Knowledge.

With which is incorporated Hardwicke's Science Gossip, and the Illustrated Scientific News.

A Monthly Record of Science.

Conducted by Wilfred Mark Webb, F.L.S., and E. S. Grew, M.A.

SEPTEMBER, 1913.

THE EXISTENCE OF LUMINOUS BIRDS.*

By COUNT L. de SIBOUR.

FEW students delve deeply in natural history without encountering the topic of luminous birds, and the pros and cons of the subject are developed by the reader with a frequency that tests the credulity of any superficial investigator. That birds having the quality of luminosity have long existed seems a fact beyond dispute. Especially true is this in England. In 1907 Sir Digby Piggott called the attention of ornithologists to the appearance of luminous birds in Cambridge, and these unusual members of the feathered family had already been noticed by others in the same county, and especially by Mr. J. H. Gurney, of Norwich, who spread the news on the Continent through the French ornithologist, M. Ternier, in *The Ornithological Review of France.*

It seems that as early as 1866, in the same county, Mr. J. A. Harvie-Brown had mentioned "moving lights" frequently seen at night. But no special attention had been paid to these reports, as they were believed to have originated in the credulous minds of country folk.

The more frequent apparitions in 1907 at last aroused the attention of naturalists, especially in France, where similar cases had been observed in the Vosges and in the Pyrenees.

According to Sir Digby Piggott, a couple of luminous birds were seen near Twiford, Norfolk, in February, 1907, by a gamekeeper, who, having killed one, identified it as a common barn owl (*Strix flammea*). In October, 1907, Mr. B. J. Purdy and Mr. Spencer saw another which was seen again on the 19th and 22nd of December. On the first occasion it seemed to have attained the maximum of luminosity, as the branches of the tree upon which it had perched were visible in the pale yellow glow. This light did not frighten the mice; for the bird was seen to drop upon them several times.

The power of the light was that of a bicycle lamp seen three or four hundred yards off, and its strength diminished considerably when the bird's flight was in a direction away from the observer. This pointed to the inference that the luminosity was confined to the breast.

According to Mr. C. L. Harman, a luminous bird was seen by him in the marshes of Haddiscoe, on the 25th day of December, 1907. Similar apparitions were recorded during the years 1907 and 1908; but in 1909 they ceased, and none has since been observed.

The glow on the breast of the barn owl is undoubtedly due to phosphorescence, and the moulting of the feathers explains its sudden extinction.

Two theories were given as to the origin of this unusual luminosity.

Mr. Gurney, who had the opportunity of observing several specimens of these birds, thought it probable that the owls had been in contact with phosphorescent wood, and that phosphorescent bacteria had attached themselves to the feathers. This opinion at first was generally accepted, especially in Norfolk, where many birds had been seen, and was apparently confirmed when Lord Lindley announced that on his property there was a

*Extracted from Articles by L. Ternier, in *The Ornithological Review of France.*

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beech tree showing a patch of phosphorescence eight inches square. It was therefore surmised that the birds had inhabited holes infested by this bacterium. The other theory was that dampness and uncleanliness of the covering of the breast had favoured a sudden growth of luminous fungi peculiar to feathers. This explanation appears to have been more plausible; for in the contact theory it would seem that the wings and head, rather than the breast, would be likely to touch the sides of the hole. Yet these parts produced little or no light. Again, it would necessitate the bird being a tree-hole dweller, whereas similar cases have been observed on Canadian blue herons, for which this kind of life is impossible.

The phenomenon is not confined strictly to wild birds. Cases are also found among domestic pigeons. The locating of the light on the breast can be explained by the fact that the feathers are finer and thicker on that part of the body than on any other, except the neck. It is also a part that the bird cannot thoroughly clean, and will therefore retain the greater part of the germs and dust gathered in flight. The peculiar increase of light during flight is probably due to a chemical action of the air producing superoxygenation, as it is well known that the agitation of a medium containing phosphorescent particles intensifies the luminosity of the latter.

The balance of argument is thus in favour of the fungi theory, and the latest observations of Señor Elorza in Spain are a confirmation of it. On several nights he saw a couple of luminous birds. Upon inquiry he was informed that they had been noticed for several years, that they lived in cliffs near by, and that they disappeared in the month of May. The description given by him did not answer to that of the Barn Owl, and it is to be supposed that we are in presence of another bird, one of nocturnal habits, offering a similar case of phosphorescence. These specimens did not live in trees, but in cliff-holes. Their disappearance in May is accounted for, as in the other cases, by the spring moulting of the feathers.

It might be of interest to look back to the works of the earlier naturalists and note that several observers were aware of the existence of luminous birds. The first to record their appearance was Pliny. He mentions them in his account of the Hercynian forest ("Historia Mundi," X, 47). Two hundred years later Solin, in the twentieth chapter of his "Polyhistoria," alludes in much the same way to what the great Latin naturalist had observed: "Soltus Hercynius aves gignit, quarum pinnae per obscurum emicant et interlucent, quamvis densa nox denset tenebras." It is probable that he was not unacquainted with Pliny's works.

The first work solely devoted to luminous animals was written in 1555 by Conrad Gessner: "De raribus et admirandis herbis, quae sive quod noctu luceant, sive quod alias ob causas lunariae nominantur, et obiter de aliis etiam rebus, quae in tenebris lucent." He speaks of plants and grass shining at night, and seems to have an obscure idea of the origin of this phenomenon, which he calls "res naturae luscentes."

Finally, in 1647, Thomas Bartholin published his great work, "De luce animalium." This is a compilation, in three volumes, of observed (and some problematical) cases of luminous animals. The third book is entirely devoted to birds, and in it are mentioned the Phoenix, the birds of Diomedes, the "Incendiaria avis," which set on fire any tree or house on which it perched; the cock "cum luce consensum alit," whose feathers had robbed from the sun their brilliant metallic shine.

But among these quaint beliefs one finds observations very probably true. In 1641, at Montpellier, in France, during a short period of famine, many fowls were brought to market. Several of these birds attracted wide attention by their unmistakable phosphorescence, and Henri de Bourbon, Prince de Condé, was called to admire them. A cock was killed "who shone on all parts of his body with a remarkably strong light," "veram totius corporis lucem . . . aperte exserint." The same year, at Montebello, according to the author, there was a hen which "shone like a ball of white fire." And Thomas Bartholin, comparing these two birds, ingeniously adds: "It is a pity that the cock did not meet the hen; for we might then have obtained a breed of incandescent fowls."

A SIMPLE METHOD OF DIFFERENTIATION BETWEEN MALTOSE AND LACTOSE IN THE SOLID STATE.

A SOLID is given which reduces Fehling's Solution and does not reduce Barfoëd's Solution. The solid must be either Lactose or Maltose.

(1) Take some of the solid and place it in a clean dry test tube.

(2) Add from 5 c.c. to 10 c.c. of absolute alcohol and shake well.

[The alcohol should not be heated as Lactose is sparingly soluble in warm alcohol and might give an erronous result.]

(3) Then filter through a clean, dry filter funnel and receive the filtrate into an evaporating dish.

(4) Evaporate the filtrate on a water-bath nearly to dryness.

(5) To the filtrate then add a few c.c.'s of diluted Fehling's Solution and warm.

[Before adding the Fehling's Solution a sample should be tested to see that it does not reduce of its own account.]

(6) If reduction takes place, Maltose is present; if no reduction, Lactose.

This differentiation can be carried out within the space of a few minutes with quite a small amount of solid and with very little apparatus. It is very useful when sugar is mixed with a protein which will prevent one from obtaining an osazone or a polariscope reading.

VICTOR FELDMAN.

THE LONDON HOSPITAL.

THE ZODIACAL LIGHT.

By the Late F. W. HENKEL, B.A., F.R.A.S.

ASTRONOMERS are generally agreed to consider this phenomenon as falling within the purview of their science, though there have not been wanting some who, by a wide extension of the term Meteorology—*τὰ μετέωρα*, "things aloft"—have rather included it under the latter heading. Inhabitants of towns, "those in populous cities pent," are not often favoured with a view of its delicate luminosity, the multitude of artificial illuminations completely veiling its feebler intensity. But in tropical regions it is a fairly regular phenomenon and, according to Humboldt and other observers, its brilliancy often greatly surpasses that of the Milky Way.

In our latitudes, the Zodiacal Light is best seen in the evenings of February and March, being then nearly perpendicular to the western horizon; in the autumn mornings it is to be similarly seen in the east before sunrise. As seen on a late February evening it has the appearance of a cone or lens-shaped beam of light reaching from the horizon towards the zenith, following generally the course of the ecliptic (or perhaps that of the Sun's equator), whence its name, the Zodiac being that part of the sky within which are performed the apparent movements of the Sun, Moon, and the principal planets. This cone has its base at the horizon, and its vertex is at a distance from the Sun's position varying from 50° to 90°, the breadth of the base being not less than 8° or more than 30°. Cassini and Mairan observed it, at times, not less than 100° from the Sun's place, and occasionally even further, showing its extension in space beyond the Earth's orbit. Humboldt and Brorsen seem to have been amongst the first to observe a second light in the East at the same time that there was a principal light in the West, a narrow band of fainter luminosity uniting the two, whilst Flammarion says that in the equatorial regions of the Earth the conical form disappears with the last trace of twilight, and by "night there is seen a luminous band forming a more or less complete circle in the sky, sometimes stretching from West to East, the parts nearest the Sun being the most brilliant, other regions less so, the whole of a pure white tint." In the region of the sky exactly opposite the Sun's place there is often seen a patch of several degrees diameter, more luminous than the surrounding portion, and this is known as the "Gegenschein," or counterglow. Whilst under the Tropics the light is of pure white colour, in our latitudes it is more commonly of a reddish tint, especially at its base; this is, however, probably due to the last traces of twilight. Humboldt, however, says ("Cosmos," Vol. I): "I have occasionally perceived not exactly a reddish coloration, nor the lower part darkened, nor even a scintillation such as Mairan asserts he has seen, but a sort of tremulous shivering of the light."

It is perhaps a little surprising that the zodiacal light seems to have escaped the notice of the ancient astronomers, unless we may suppose that a reference to the "trabes" by Pliny, in his "Natural History," may be so interpreted; but this is more probably an allusion to the aurora. Kepler and Descartes make obscure allusions which may be interpreted to indicate their familiarity with it; but the earliest authentic mention of the light occurs in the works of Childrey, Chaplain to Lord Henry Somerset, who, in his "Natural History of England" (1659) and his "Britannia Baconica" (1661), was the first to draw the attention of his contemporaries to the remarkable observations made by him during several previous years, in the evenings of February and March, after sunset. About twenty years later, Dominique Cassini gave considerable attention to the phenomena as seen in Central Europe, and studied them "in all their bearings with regard to space," formulating a theory of their origin which differs but little from that generally admitted by present-day astronomers. He considered that the light was produced by a ring of small planetary bodies revolving in orbits nearly in the plane of the Ecliptic and reflecting the light of the Sun. He even thought that the fall of meteoric stones or bolides might be due to the passage of our Earth through this ring. The principal difference between this and later views consists in regarding the innumerable small particles as rather forming a thin, flat sheet partly lying between the Earth's orbit and the Sun and partly beyond it, the light being due to reflection mainly, but perhaps, as we shall see later, to a small extent intrinsic also. It is by no means impossible that to the action of the denser part of this layer of "meteoric dust" within the orbit of Mercury may be due the unexplained motion of the perihelion of that planet's orbit as detected by Leverrier. Sir John Herschel says: "It may be conjectured to be no other than the denser part of that medium which, as we have reason to believe, resists the motion of comets, loaded, perhaps, with the actual materials of the tails of millions of those bodies of which they have been stripped in their successive perihelion passages."

Liais and Mayer thought that to this layer might be referred the maintenance of the Sun's light and heat, "the meteoric theory of solar radiant energy." Materials must be continually falling upon the Sun's surface, and the "arrested motion" transformed into heat, thus making up for that lost by radiation, so

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that the Sun might long continue in this way to heat and illuminate the planets. But the *insufficiency* of this process is a fatal objection, except as possibly affording a minute portion of the solar radiation; for, were the Sun's heat thus maintained at its present rate of emission, calculation shows that our own Earth and the nearer planets would be subject to a bombardment also, sufficient to add about fifty tons of meteoric matter on each square mile of the Earth's surface per day; whereas in reality the actual amount falling is not one-millionth of that quantity. The fall of sufficient material in such vast quantity implies the presence of a yet greater amount in the surrounding regions, and very evident effects upon the motions of the planets would also be perceived which are not observed. Nevertheless, the idea that a balance between expenditure and receipts is kept up in this way seems so beautiful an one that we may perhaps be permitted to regret that it is not true.

Long-continued observations of the light were made by the Rev. G. Jones, chaplain of the American steamship "Mississippi," during a cruise of two years round the world, and his observations and results were published in a beautiful volume during the year 1858. The final conclusion at which he arrived from the totality of his observations was that the zodiacal light is *produced by a nebulous ring having for its centre the Earth*, which lies within the orbit of the Moon; in other words, a kind of terrestrial ring like one of the rings of Saturn. Captain Wilkes, a well-known American navigator, objected to Jones's views and proposed an alternative theory that the zodiacal light is simply a terrestrial meteorological phenomenon, the result of the illumination of that part of the Earth's atmosphere upon which the sun falls vertically within the tropics. The Dutch observer Gronemann similarly considered the light to be of terrestrial origin, and denied that the relation asserted to exist between the luminous cones seen in the east in the morning and those seen in the west during the evening had been established; he also declared that it had not even been proved that they shared the apparent diurnal motion of the heavenly bodies. In 1876 Serpieri, of Urbino, presented to the Italian Spectroscopic Society a memoir dealing with the results obtained by various previous observers, and gave as his opinion that the light was of electrical origin, perhaps analogous to the aurora. Thus we see that there is still much to be done before we can be said satisfactorily to understand this mysterious phenomenon, although, as we shall point out later on, there are good reasons for thinking that the "auroral" theory of the zodiacal light arises from a confusion of ideas.

Long ago Humboldt, whose interest had been excited by finding the intensity of the light much greater in Spain than in Germany, expressed his astonishment at the variability of this phenomenon under the tropical skies of South America. Even whilst its luminosity was greatest it would for some minutes diminish appreciably, and then without warning brighten up again to its former intensity. "The strength of the light increased in a remarkable manner as I approached the Equator in Southern America. In the constantly clear and dry atmosphere of Cumana, in the grassy llanos of Caracas, on the elevated plains of Quito, and in the Gulf of Mexico, especially on the plateaux (of ten thousand to twelve thousand feet above sea level), where I stayed for some time, I noticed that its brilliancy often surpassed that of the brightest part of the Milky Way between Argus and Sagittarius, or, speaking of the part more familiar to us in the northern hemisphere, that part between Aquila and Cygnus" ("Cosmos," Vol. IV). On the whole, however, Humboldt considered that the brilliancy of the zodiacal light did not increase with the altitude of the region where it was observed. He insisted especially upon "the intrinsic variability of the phenomenon itself," but he did not dispute the possibility of the influence of varying atmospheric conditions, the greater or less transparency of the upper and lower strata of the air upon its brightness, as we have already noticed with regard to the coloration perceived in extra-tropical regions, scintillation, and so on.

Amongst others who have studied the various phenomena, Professor Searle has also devoted much time and thought to the different theories proposed. Dealing with the observations of Jones and others he concludes that the zodiacal light varies in position during the course of the year, being more to the north in autumn than in spring (of our hemisphere); atmospheric absorption has a great influence also upon its apparent position; the zone of the sky occupied by the minor planets presents peculiarities like those of the zone occupied by the light, and thus one is led to think that the latter also is due, in part at least, to small bodies moving in planetary orbits. The light does not interfere with the visibility of even faint stars, and it disappears by setting, and not by growing fainter. This last movement, due to the Earth's diurnal motion, as we have seen, was denied by Gronemann.

From observations made at sea whilst in the Tropics during 1862 Helis concluded that the change of position of the light depends more on the time of year than on the situation of the observer. Colonel Tupman made a number of observations from 1869 to 1871 in Southern Europe, and gave an account of his work in *The Monthly Notices of the Royal Astronomical Society*, Vol. XXXII. He stated that the axis of symmetry of the light with regard to the Ecliptic varied considerably during the course of the year, being almost parallel to that plane in winter and making an angle of as much as 20° with it in August and September. He also asserted that the plane of the light *did not pass through the Sun*. If this be indeed the case it would seem that the matter composing it does not turn round the Sun, but his observations differ very

considerably from those of others. About the same time the late A. C. Ranyard, formerly editor of "KNOWLEDGE," was in Sicily for the purpose of observing the famous total eclipse of the Sun in 1870. He examined the luminosity of the zodiacal light with the Savart polariscope, and saw that this gave distinct signs of polarisation, thus concluding that the material giving rise to it is either composed of particles so small that their diameters are comparable with the wave-length of light, or else is composed of matter capable of giving "specular reflection." Ängstrom, of Upsala, the famous spectroscopist, concluded from his observations that the substance emitting this light is the same as that which causes the aurora. He thought that he saw the "brilliant auroral line" (5567) in its spectrum; but as the aurora is a phenomenon of far greater frequency in Sweden than in regions further south, his observations, through the possible confusion between two coëxistent phenomena, are subject to considerable uncertainty.

Acrimiz, at Cadiz, also observed a faint continuous spectrum with two brilliant lines, one yellow ("*probably* an auroral line") and another bright line in the blue, more refrangible than the F line of hydrogen, which he thought was identical with another auroral line, but which he could not identify with certainty. "As," says Professor Michie Smith, "his observations were made with an instrument whose dispersion was much too great to allow of the visibility of the faint luminosity of the zodiacal light," it seems fairly certain that this was not the phenomenon which he had observed at all.

Important observations have been made by Barnard in America, Max Wolf at Heidelberg, Innes at Johannesberg, Ferrari, Maxwell Hall, Backhouse, and others; but to enable us to arrive at a completely satisfactory theory it is evident that we must have more observations made in elevated regions, where the influence of the denser part of the atmosphere and other disturbing causes have less influence, as well as careful measurements made over a term of years. Hitherto we have had to rely mainly upon observations made too near the sea level, under unfavourable conditions, and of a spasmodic nature. Thus it can scarcely be wondered at that there are divers views and conflicting theories as to the true nature of the zodiacal light.

We have already alluded to a yet more mysterious phenomenon, the "Gegenschein" (counterglow), as Brorsen called it when he discovered it some sixty years since. It is a faint luminosity of variable size, in general more or less of the form of an oval patch, but occasionally lens-shaped, lying along the Ecliptic or close to it, its longitude differing from that of the Sun by 180°, whence its name, from its always being in exactly the opposite part of the sky. A very extensive series of observations has been made by Mr. T. W. Backhouse, the well-known astronomer, of West Hendon House, Sunderland, for more than thirty years, and he has published his results in Vol. II of the publications of that observatory. He finds that the ordinary form of the Gegenschein is nearly circular, its diameter about 7°, its centre lying a little to the north of the Ecliptic (0°·75 N. lat.). The Gegenschein precedes the "anti-solar point" in the sky by 0°·6 of longitude at the most.*

Professor Barnard being at Nashville, Tennessee, U.S.A., during the autumn of 1883, whilst searching for comets, one night noticed a feeble luminosity in the sky "near Pegasus." He thought at first that this was due to local illumination, although it was remarkably steady. The following night it was still there, and by observation of its position for several nights running he found that it moved towards the east along the Ecliptic at the rate of a degree per day. He had rediscovered the Gegenschein. Following up his first observations he continued to make numerous examinations of the object, discovering various changes during the course of the year. Fifteen years of observation convinced him that these changes are seasonal, and are repeated annually in the same part of the sky.

About the Gegenschein there is also a variety of theories. Some are inclined to regard it as due to "nebulous" matter rejected from the Earth, thus forming a kind of tail like that of a comet. Very little of such matter would be sufficient to produce its feeble luminosity, which is visible only upon a perfectly dark sky. If it be indeed true that this is the nature of the Gegenschein, then our Earth would be richer in appendages than has been hitherto supposed, possessing, perhaps, a ring or rings like those of Saturn (Jones's theory of the Zodiacal Light) and a tail like that of a comet (the "Gegenschein"). Professor Barnard, however, is inclined to consider the latter as a purely atmospheric phenomenon, notwithstanding his observations and the absence of measurable parallax, which he admits to be a weighty objection to such a view ("Popular Astronomy," No. 64). Professor Searle, whose views have been already referred to, considers that the zodiacal light is due to the reflection of sunlight by millions of minute planetary bodies and particles of "cosmical dust," too small to be seen separately. When they are directly opposite to the Sun in the sky each of these particles shines with a "full" disc like the Moon in the same position, and the vast collection of small objects fully illuminated must increase the general luminosity of this region. In other positions less of their illuminated sides are turned towards us, and therefore they are not so easily visible. Being at the same time nearest to the Earth, and full when in opposition, we have the Gegenschein. Mr. Evershed, of Kodaikanal, in India, explains the Gegenschein as produced by molecules of hydrogen and helium—the

* Celestial longitude is the angular distance, measured along the Ecliptic (*not* along the Equator) from the first point of Aries, in degrees and other units of angular measure. Latitude is the angular distance north or south from the Ecliptic towards its poles.

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two lightest known gases—which are driven away from the Earth in the direction opposite to the Sun; but the absence of sensible parallax is a serious objection here also, unless we suppose that these particles are already far beyond the Moon when they are observed. Gyldén, the Swedish mathematical astronomer, has shown that meteors passing near opposition in the neighbourhood of the Earth could follow one or other of several oscillating orbits round the point of opposition before resuming their course around the Earth or Sun. Even if these minute particles were very numerous they would not exercise any appreciable attraction upon one another or much influence on the Earth, but still they would present the appearance of a kind of luminous fog in opposition to the Sun. The centre of this luminous path would be the point in the sky directly opposite the Sun: its outline elliptical and its major axis lying along the Ecliptic. Since the observed deviation from perfect circularity is but small, it must be concluded that the meteors move round the Earth in all directions, without there being many more in the ecliptic plane than in any other.

Mr. Innes has proposed a modification of an earlier theory to account for the Gegenschein. He considers that the Earth is continually bombarded by meteorites which give off "corpuscles." These latter, repelled by the Sun and Earth together, produce a kind of feeble tail, smaller than that of a comet, which is visible on a dark night in the part of the sky just opposite the Sun.

Although, as we have seen from the various accounts and views just given, there is still considerable divergence of opinion as to its true nature, and much still remains for observation, especially in regions more favoured than our own, yet we may conclude that the general character of the zodiacal light is fairly well established. It is almost certainly due to innumerable particles of matter moving round the Sun in elliptic orbits more or less eccentric, their paths lying in or nearly in the plane of the Earth's orbit in a widely extended, but comparatively thin, zone, so that the denser part has the form of a thin, flat sheet, like one of the rings of Saturn, lying partly within and partly without the Earth's orbit. As there is no definite certain limit to the Sun's corona it is possible that the inner part of this sheet is connected with the outer part of the former, and so in a *certain sense* the zodiacal light might be regarded as an extension of the corona (as the late Sir William Huggins was inclined to think); but this seems an extreme view, for we might similarly regard the planets also as so connected. There are not wanting proofs of the existence of a resisting medium whose influence in former ages upon the planetary orbits is so evident, drawing them inwards and making their paths more nearly circular than would otherwise have been the case; and though most of the material composing this medium has probably long since fallen upon the Sun and planets, yet there most likely remains enough of it in the vast regions of space separating the larger bodies of our system from one another to become visible to us by reflection of sunlight, and perhaps also by a feeble intrinsic luminosity, like that of the nebulae, as the zodiacal light.

PHOTOGRAPHIC EFFECT OF CHEMICAL RËACTIONS.

By J. H. VINCENT, M.A., D.Sc., AND J. MARLEY, B.Sc.,

London County Council, Paddington Technical Institute.

UNDER the above title, in Mr. Ainsworth Mitchell's Chemical Notes in "KNOWLEDGE" for March, 1912, an abstract of a paper by Matuschek and Nenning (*Chem. Zeit.*, 1912, XXXVI, 21) is given and commented on. The results were of such a striking nature and offered so interesting a field for further investigation that we tried many experiments on the same lines. Matuschek and Nenning state that many cases of chemical action are accompanied by the emission of light, which acts on a photographic plate after passing through glass. Our results differ altogether from those obtained by these authors. In a paper on this subject recently published in the *Chemical News* (March 20th, 1913), we state that "At first some slight photographic effects were noted which could not be traced to known chemical action of the kind studied by Russell, and which is attributed to hydrogen peroxide. These positive results disappeared as experience was gained in protecting the photographic plate from the action of extraneous light. As some of the experiments have lasted several weeks, the precautions against the accidental entry of light to the plate cannot be too elaborate. In all cases any vapours, and so on, arising from the substances engaging in the chemical action must also be prevented from acting on the plate. Apart from the Russell effect, due to metal screens, and so on, we have been unable to find any evidence of action on the plates.

The reäctions tested were:—

1. Action of sulphuric acid on zinc.
2. Action of hydrochloric acid on sodium-metasilicate.
3. Action of nitric acid on lead.
4. Hardening of plaster of Paris.
5. Electrolysis of water with platinum electrodes.

It is difficult to account for the positive effects observed by Matuschek and Nenning. Properly controlled experiments with vessels containing water heated electrically and with paraffin wax heated electrically, have convinced us that the heat produced by chemical action is not competent to account for the apparent positive results. We find then no evidence of any radiation capable of acting on a photographic plate after passing through glass."

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THE MODERN EVOLUTION OF THE STEREOSCOPE.

By A. LOCKETT.

THE valuable aid offered by the stereoscope to the scientific investigator is again attracting notice. In astronomy, photo-surveying, the surgical applications of radiography, photo - micrography, the treatment of certain diseases of the eyes, and in many other new and often unexpected ways, stereoscopy places a fresh power in the hands both of the inquirer and the expert. Even the cinematograph is now made to give moving pictures in natural relief—a development opening out a wide vista of possibilities.

The stereoscope itself has been greatly improved of late years, and a better understanding of the principles on which it depends has led to the production of new models embodying important modifications. This being so, the time seems not inopportune for a brief sketch of the modern evolution of stereoscopic apparatus and some consideration of those factors that have to be studied in order to secure the maximum satisfaction of optical and physiological requirements. Clearly what is needed is the best practical performance, together with the greatest possible convenience and the least complication. These different qualities may not be obtainable together, but that will evidently be the most perfect instrument which enables the truest balance to be struck between them.

Like telescopes, most stereoscopes may be divided into two classes, those, namely, that utilise reflection and those depending upon refraction. A third class which relies upon neither, but includes several instruments or systems of unique character, may, perhaps, most conveniently be considered first.

The earliest stereoscope, Elliott's—designed in 1834, though not constructed till 1839—dispensed with all optical intervention, the two pictures, or rather diagrams—for photography was then non-existent — being viewed direct by the observer. The instrument thus possessed two excellent features; but, unfortunately, it was necessary to cross the axes of the eyes in a somewhat unnatural manner, which called, in many cases, for a little troublesome practice before it could be accomplished. On that account Elliott's stereoscope never came into general use.

A modified form of the Elliott instrument, devised by the writer in 1912, may be of interest. As shown by Figure 346, it consists of a tapering box, A, having two oval openings at the front for the observer's eyes and a rectangular opening at the back. In the diagram the top is removed for clearness of illustration. The box is blackened inside, and to the bottom is attached a narrow piece, B, on which slides a holder similar to those used on the ordinary American stereoscopes. The two photographs must not, as is usual, be transposed in mounting, but should be allowed to remain just as they are printed from the negative, the picture for the right eye being on the left and that for the left eye on the right. To use the apparatus it is held by the handle, D, and the stereograph is moved to and fro, keeping one eye shut, until one picture appears to fill up the aperture in the back. On opening the other eye the combined images will then usually be seen in stereoscopic relief, or, if not, a few further trials will ensure this result. The principle involved is obvious. Owing to the fact that nothing can be seen except through the back opening, placed midway between the two pictures, the right eye can only perceive the left-hand picture, while the left eye beholds only the right-hand one. At the same time they are both mentally referred to an apparently identical position, so that they coalesce and give the effect of natural relief.

For a reason to be explained later, another unique method, the parallax system of F. E. Ives, though of much later date (1903), may not inappropriately be dealt with next. By this highly ingenious method each stereograph carries its own viewing arrangement, so that no separate instrument is required. In making the negative, the two slightly different images are superposed on each other. This may be done in various ways, but that commonly adopted is to use on the camera a single plano-convex lens of about three inches diameter, placing behind this a diaphragm having two small openings two and a half inches apart. A screen ruled with fine vertical lines, about one hundred to the inch, is interposed between the lens and the plate at such a distance from the latter that it splits the two images into a series of adjacent lines, every alternate line consisting of a portion of one image only, while the intermediate lines represent parts of the other image. From the resulting negative, a transparency is made and is bound up with a line screen of the same spacing as that with which the photograph was taken, kept at a similar distance by a cardboard mask. On holding the bound-up transparency at the correct distance from the eyes, usually about twelve inches, perfect and beautiful stereoscopic relief is perceived. Figure 348 illustrates, on a much enlarged scale, the precise action of the ruled viewing screen, A being the transparency, B the screen, and C and D the eyes of the observer. It is obvious that either eye sees only the intermediate portions forming its own proper picture, while the two pictures are at the same time superposed and united. For the best result, the opaque lines of the taking screen should be twice the width of the transparent interspaces, as this prevents the parallax

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lines from running into each other when developed.

If we consider any two adjacent spaces of the composite transparency in relation to a single opening in the line screen, as shown by Figure 349, the remarkable similarity in principle to Elliott's early apparatus will be evident. The Ives stereograph consists, in fact, of hundreds of tiny Elliott stereoscopes, all inspected simultaneously. While the results obtained are unexceptionable, there are two obstacles to the general adoption of this system. One is the necessity of precise adjustment of the distance of the ruled screen from the plate in relation to the camera extension and the separation of the two view points, besides the corresponding care required in binding up the positive, the other being the fact that only transparencies can be made.

Yet a third method of stereoscopy, utilising neither reflection nor refraction, is the anaglyph system of Louis Ducos Du Hauron (1890) in which the two pictures forming the stereograph are printed, one over the other, in red and blue ink respectively. The resulting jumbled combination is viewed through spectacles containing a red and a blue glass, or similarly tinted pieces of gelatine. Through the red glass, the red image is invisible and the green one appears black, while through the green glass the reverse is the case. As each eye, therefore, sees only its particular picture, and the two are superposed, stereoscopic vision results. Prints of any size may be produced and viewed in this way, and the stereographs evidently occupy only half the space that would be necessary if the two pictures were placed side by side in the usual manner. The drawbacks are a considerable loss of light from the presence of the colour filters, and the fact that the prints cannot be inspected without the viewing arrangement, as is often desired. Though Du Hauron was undoubtedly the first to employ the foregoing method with printed stereographs, it should be stated that the principle was foreshadowed by Dove in 1843, and by Rollmann in 1853, while D'Almeida, in 1857, used a very similar system, but with red and green glasses for stereoscopic projection by the lantern.

Turning now to refracting stereoscopes, that of Sir David Brewster, familiar as the old box-form pattern of early Victorian days, comes first in order. Initially studied by its inventor in 1844, and communicated to the British Association in 1849, this instrument was not placed on the market till 1851, when Duboscq, of Paris, undertook its manufacture. The principle of Brewster's stereoscope is probably so well known that explanation is almost superfluous. A few words, however, may be desirable. The lenses or prisms A and B (Figure 350), cut from the two halves of a bi-convex lens and turned with their thin edges inwards, so refract the rays from the two pictures C and D that the eyes of the observer see them converged together, both images being superposed at E. Since, nevertheless, each eye sees only its own proper half of the stereograph, the result is stereoscopic relief. A more convenient form of Brewster's instrument, designed by Oliver Wendell Holmes in 1861, with the further improvement of a sliding view-holder, added by J. L. Bates in 1864, is now in general use.

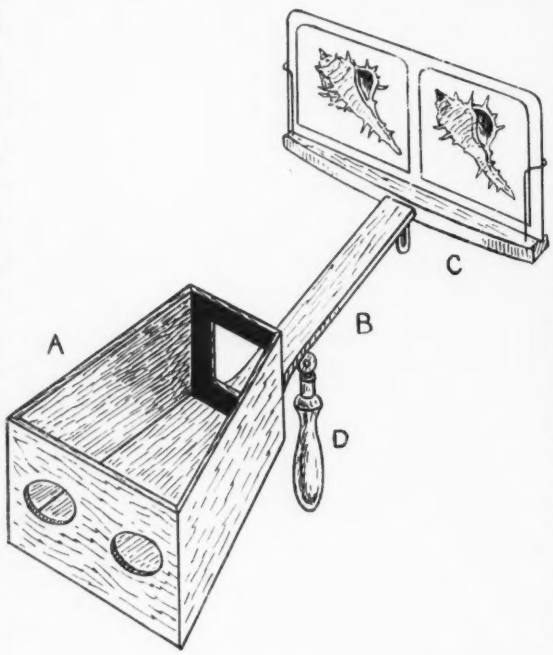

FIGURE 346.

The refracting stereoscope has the advantages that no light is lost and that the image is magnified. Counterbalancing these merits are the facts that in magnifying the prints the grain of the paper is also enlarged, detracting from the fineness of the image; that only pictures of a small and rather awkward size can be employed; that the instrument has to be focused to suit differences of vision; and, finally, that a slight degree of distortion, if not of other optical aberrations, is present. It may also be added that some observers have difficulty in combining the two images with this type of apparatus.

Variations of Brewster's instrument have been numerous. Whole lenses have, for instance, been used, as in the telescopic stereoscope of De la Blanchère, which resembled a pair of opera glasses with the two tubes adjustable as to convergence. It is not, by the way, generally known that if we look through an ordinary opera-glass pointed wrong way round at a stereoscopic slide, a single small image in relief will be seen. Another interesting stereoscope, devised by Steinhauser, had lenses contrary to those of Brewster's apparatus, causing the optic axes to cross, so that untransposed stereographs could be utilised. The chief modern improvements on Brewster's instrument, apart from the American hood and sliding holder, have been the employment of achromatic instead of single lenses, and provision

From a stereograph *by M. L. Chapuis.*

FIGURE 347.

The Bones of the Head. From a century-old anatomical preparation in Dijon Museum. To be inspected with an ordinary mirror, as described on page 332, or with the Pigeon stereoscope.

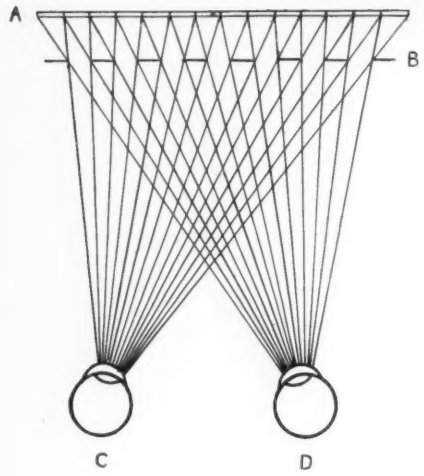

FIGURE 348.
The Principle of Ives's Parallax Stereograph.

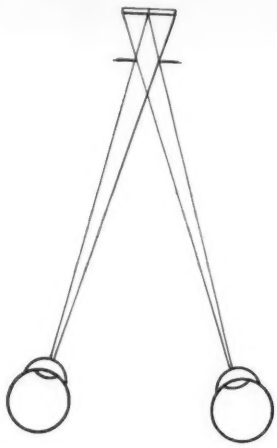

FIGURE 349.
A Diagram illustrating Analogy between Ives's system and Elliott's Instrument.

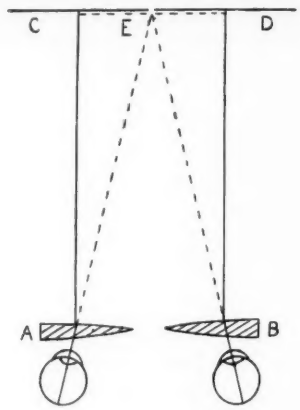

FIGURE 350.
The Principle of Brewster's Refracting Stereoscope.

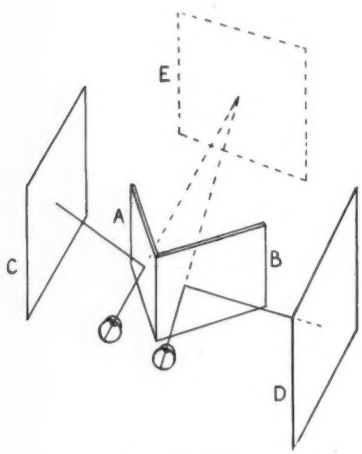

FIGURE 351.
The Principle of Wheatstone's Reflecting Stereoscope.

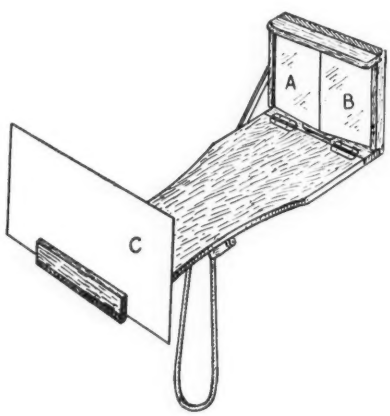

FIGURE 352.
The "Reflectascope."

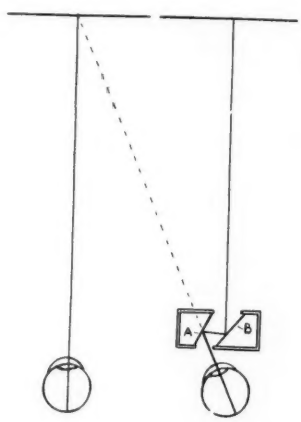

FIGURE 353.
Theodore Brown's pocket Reflecting Stereoscope.

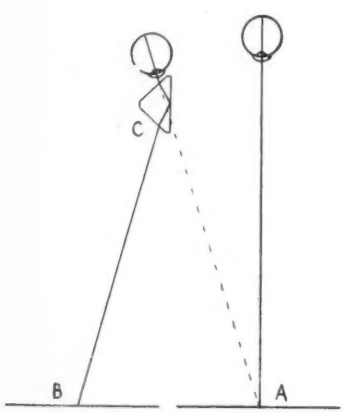

FIGURE 354.
The Principle of Pigeon's Prism Stereoscope.

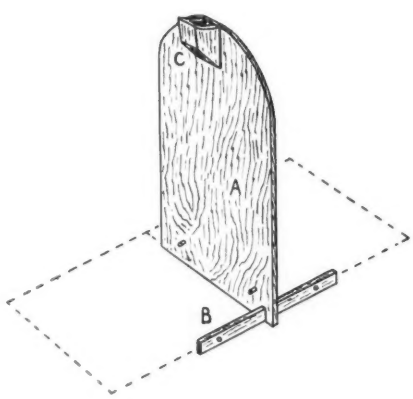

FIGURE 355.
The constructive details of Pigeon's Prism Stereoscope.

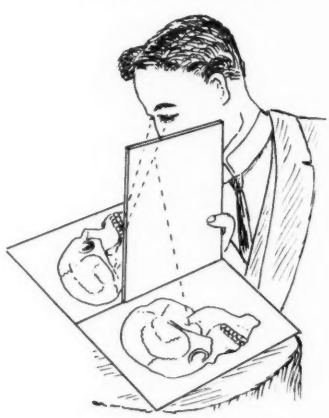

FIGURE 356.
The method of inspecting Pigeon Stereographs with an ordinary Plane Mirror.

for altering the separation between them to suit the distance between the eyes of any observer. Such refinements, however, are still only met with in the higher-priced lenticular stereoscopes.

In the opinion of many, the reflecting principle offers the fewest disadvantages, now that its earlier constructional drawbacks have been overcome. It is not without interest to trace the evolution of the reflecting stereoscope, from the cumbrousness and complexity which at first distinguished it to its latest developments and refinements. The earliest stereoscopic apparatus making use of reflection was invented by Sir Charles Wheatstone in 1838—next in order, therefore, to Elliott's apparatus. As shown by Figure 351, it had two plane mirrors, A and B, inclined together at an angle of 90°, silvered side outward, the two pictures C and D composing the stereograph being placed one at each side, and the observer viewing their images in the mirrors. As both images were reflected into an identical position at E, and thereby made to coalesce, while, at the same time, each eye saw only its own particular picture, stereoscopic vision resulted. The chief drawbacks of this arrangement were that the two pictures had to be inserted separately; that, if any adjustment were needed, both pictures had to be advanced towards or withdrawn from the mirrors simultaneously, which involved the use of a clumsy double-threaded screw; that the reflected image was necessarily reversed as regards right and left; and that the efficient lighting of both pictures, from two contrary directions, presented serious difficulties. This instrument was therefore soon superseded. It may be remarked that, besides claiming credit for the inception of the first reflecting stereoscope, strong ground exists for believing that Wheatstone was aware of the principle of—if he had not actually constructed—the lenticular form prior even to Brewster.

There have been many variants on Wheatstone's instrument, since it is obvious that the two prints and mirrors may be arranged in numerous different ways. One of these, known as the Reflectascope, is illustrated by Figure 352. As will be noticed, two plane mirrors are placed at A and B, joining at a very obtuse angle. The stereoscopic slide, the back only of which is seen in the figure, is inserted in a holder at C, and the observer, looking over the slide, sees in the mirrors a single picture in relief. The chief drawback here is that the join between the mirrors shows, though almost imperceptibly, as a thin line across the centre of the combined image. If the two mirrors are inclined inwards away from the slide, instead of outwards, the arrangement otherwise remaining the same, non-transposed stereoscopic slides may be used. In both cases the image is reversed as regards right and left.

It is an evident advantage that optical aids should be dispensed with so far as possible, in order that the eyes view the stereograph direct. Except in Elliott's instrument, the drawbacks of which have been pointed out, this desideratum is incapable of practical fulfilment. There are, however, several systems in which one eye at least regards its own picture direct. Various suggestions to that effect were made, at different times, by H. W. Dove, Brewster, and Rollmann; but, as a modern instance of efficient performance combined with convenience, Theodore Brown's tiny pocket stereoscope (1895), doubtless the smallest made, may be mentioned. In this, as shown by Figure 353, two small mirrors, A and B, are enclosed in a case, nearly but not quite parallel with each other. Looking through an aperture in the case, the right eye views its proper picture by double reflection, apparently superposed on the left-hand picture, the latter being seen direct by the left eye. The same idea is obviously applicable to a double reflection prism having sides of suitable angle.

Mirrors, to give optically perfect results, should be surface-silvered, but are then unfortunately liable to tarnish, and are very susceptible to injury by moisture, scratches, or abrasion. Reflecting prisms serve all the purposes of mirrors and are free from these disadvantages, besides being more easily cleaned. Many prismatic stereoscopes have been constructed, among which may be recorded that of Girard-Teulon (1861), in which four total reflection prisms were used, and several forms of apparatus invented by Sir Howard Grubb (1878), in which the two stereographic prints were mounted one above the other, instead of side by side. In another instrument by Grubb the two pictures of an ordinary stereoscopic transparency were thrown in superposition on to a concave mirror by means of a combination of prisms and lenses, the observer, at a suitable distance, seeing an aerial image in relief. It may be mentioned that Duboscq and also Jequezel, both in 1857, made stereoscopes having prisms as well as lenses, so that both reflection and refraction were employed. These instruments were, however, practically modifications of Brewster's apparatus.

Whether mirrors or prisms are used, it is fairly evident that a double reflection must involve more loss of light, and must require a more exact adjustment than a single one. There is therefore a special advantage in the prism stereoscope invented by Professor Léon Pigeon, of Dijon (1910), who is also known as the contriver of the compact and useful book-form mirror stereoscope named the "Dixio" (1905). In Professor Pigeon's prism stereoscope (see Figure 354) the right-hand picture, A, is viewed direct, while the left-hand one, B, is seen by a single reflection in the prism, C, apparently superposed on A. It is necessary that the left-hand print should be laterally reversed, a condition easily fulfilled, among other obvious ways, by making the prints in carbon, one by single and the other by double transfer; or, if film negatives are used, by printing the left-hand picture from the back. As shown by Figure 355, the apparatus consists of an upright panel, A, supported by a narrow cross-piece, B, the prism being mounted in a hood, C, which screens stray light from the left eye. The prints, which may be of quite large size if desired, are laid flat on a table and the instrument is placed over the

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central line between the two pictures, as indicated. Large prints may conveniently be hinged together by a tape glued across the back at the junction, in order that they may be kept unmixed and may fold up when not in use. For prints over 8-in.×6-in. the stereoscope should be raised in the hand, so that a longer viewing distance is obtained. Besides its ordinary purpose the model illustrated is very suitable for viewing stereoscopic illustrations in books. Another pattern, it may be stated, makes provision for the inspection of transparencies and autochromes. On the whole, the Pigeon stereoscope—the last word, so far, in reflecting instruments—certainly seems to offer a maximum of efficiency, combined with extreme simplicity. The image is exceedingly clear and brilliant, while with a front lighting absolute uniformity of illumination is easily secured. Those who would like to have ocular demonstration of the principle involved may readily do so by using an ordinary plane mirror, about eight inches or ten inches high, supporting it in a vertical position on the line between the two prints, the silvered surface being to the left, as shown by Figure 347. For the purpose of experiment an admirable anatomical study from an exhibit in Dijon Museum, taken by M. L. Chapuis in collaboration with Professor Pigeon, and reproduced by kind permission of the latter, will be found on page 329. The effect with an ordinary mirror will not, of course, be so good as with a surface-silvered one, or with the prism, but will still enable an excellent idea to be obtained of the results possible.

It may be mentioned that an ophthalmological stereoscope on the reflecting principle has been invented by Professor Pigeon, for the diagnosis and treatment of strabismus, or squinting. Besides its primary use, it may be employed for the direct study of the problems of binocular vision; for investigations concerning the function of the motor muscles of the eye and paralysis of these muscles; for the physiological fusion of colour; for the medico-legal examination of alterations in sight, real or simulated; and for many other purposes.

In conclusion, some remarks concerning the relative merits of small and of large stereographs will not be irrelevant. It has been stated by several writers that a small print inspected at a short focal distance gives really the same stereoscopic effect as a larger print viewed from a greater distance. To a certain extent this is true; but there is a grave fallacy in the reasoning, since the much greater amount of detail secured in the larger picture is overlooked. To make the matter plainer, compare the case of an enlargement made from a small negative with that of a large direct photograph the same size as the enlargement. There can be no question as to which of the two will give the more detail. The large direct print will show many things that are not visible in the enlargement, it being, therefore, clear that they are absent in the small picture. Large prints, moreover, are seen with less fatigue, make a more definite impression, need no objectionable magnification, may be made with lenses of a more acceptable focal length, and are more useful for purposes of investigation or for the deduction of measurements.

*BEDROCK.**

IN the current number of *Bedrock* the "Hermit of Prague" makes fun of the Headmaster of Eton for taking seriously Miss Curtis's New Mysticism, the nature of which she explains in her book "Meditation and Health." This the "Hermit of Prague" describes as one of the numerous wholly unscientific works on "mind-healing" that for several decades have gained a curious vogue in the United States.

Under the title of "Mendelism, Mutation and Mimicry," Professor Punnett very clearly sets forth what in his mind are the leading difficulties against accepting the theory of mimicry as explaining the likeness between various butterflies. He characterises as an enormous assumption Professor Poulton's belief that a very slight accidental variation on the part of a species in the direction of a pattern which is utterly different, will be detected by its enemies and cause them to let it alone. He asks how an enemy endowed with such remarkable discrimination could fail to distinguish between mimic and model even in cases of the closest resemblance yet recorded.

The evidence in favour of the existence of pre-palaeolithic man is brought forward by Mr. J. Reid Moir, and he sums up his arguments by saying that there is one thing, and one thing only, left for the opponents of the pre-palaeolithic implements to do if they wish their views to be taken seriously, and that is to subject flints to some unguided, natural force, and produce forms indistinguishable from those which are in dispute.

Mr. Hugh S. Elliot, commenting upon Dr. McDougall's article in the previous number of *Bedrock*, says that while historically and scientifically Dr. McDougall is justified in applying the name "Materialism," to his (Mr. Elliot's) published views, the word carries with it in the public mind many connotations which are very far from the opinions of those who profess it. The name "Scientific Materialism" is suggested instead and used as a title for the article, which is an answer to Dr. McDougall.

Among the contents of the same number is a contribution by "A Business Man," which he calls "The Truth about Telepathy." The writer grumbles because Sir Oliver Lodge attributes motives to him, but we cannot say that we admire the methods of "A Business Man."

* For July, 1913.

CATALEPSY IN PHASMIDAE.

By PETER SCHMIDT.

Privat Dozent of the Imperial University of St. Petersburg.

IN the following article I wish to give the results of some observations and experiments upon cataleptical phenomena in connection with an Indian insect—*Carausius morosus* Br. v. W.—an Orthopteron of the family of *Phasmidae*. The representatives of this family are all tropical or subtropical insects of green, grey or brown colour and protectively resemble the stems of the plants on which they feed. The habitat of *Carausius morosus*, which will breed during any month of the year in my laboratory, so far as I am aware, is North India and Afghanistan; but, five or six years ago it was imported into Germany *via* Hamburg and thence came to St. Petersburg, where it breeds now in almost all zoölogical laboratories. The insects are so interesting in many respects and their breeding is so easy that it is really strange that these Indian emigrants have up to the present been so little known in other countries. Their biology was studied in detail by an eminent German entomologist, Otto Meissner,* who published a valuable paper, but strangely did not notice the most interesting feature about them, viz., their catalepsy.

These green stem-like creatures with red markings on the femora of the forelegs show generally very little movement. They may sit motionless during the whole day on the stems of plants or on the sides of a glass jar (see Figure 357), and only occasionally do they begin to move, and then they creep in a very lazy way. They feed generally at night, and it is very seldom that one can see a *Carausius* eating leaves by day.

The insects may be thought at first sight to be sleeping or reposing, but closer observation and some very simple experiments will produce the conviction that we have to do here with a catalepsy exactly like that artificially produced in higher animals. Indeed, it has long been known that many vertebrates can be hypnotised and made motionless by very simple methods. If we lay a rabbit on his back on the table and fix his head and his feet for a few seconds, we shall make him cataleptic—he will lie motionless for some minutes, and his muscles will be strained as in a hypnotised human subject. The same thing can be done with a crayfish—one can stand him vertically on his head and the first pair of legs, and he will keep completely motionless for many hours as if bewitched.

Now if we look more carefully at a *Carausius* in his quiet state we shall see that his feet and whole body are rigid, and his muscles are strained as in catalepsy. Indeed, if we gently take hold of a leg with a pair of forceps, bend it, and put it in some pose or other, we see that it keeps this pose for a very long time, even if it is unnatural and uncomfortable. In the same way we can raise the head and the prothorax of the animal and move asunder the first pair of legs, so that *Carausius* takes approximately the position of a *Mantis* (see Figure 359). In such an artificial pose *Carausius* will stay for many hours.

When I had detected this interesting muscular state in the quiet *Carausius* I tried some other experiments, and after a number of trials it occurred to me, for instance, to stand the insect on its head (see Figure 358) and to give him a still more amusing pose which I have called the "wrestling bridge" (see Figure 360). In one of the experiments a cataleptical *Carausius* remained on its head for four and a half hours! And he showed not the slightest signs of fatigue.

All these experiments sufficiently demonstrate that the muscles of *Carausius* are really in a state which is named by physiologists "*flexibilitas cerea*" (*i.e.*, wax flexibility). They are strained, but not extremely as in the state of tetanus: they can be stretched more and remain in a given position. Expressly the same state of muscles is observed in the cases of catalepsy or "hypnosis" in higher animals and in man.

How strong is this rigidity of muscles is seen from the experiment shown in Figure 361. Here a *Carausius* is posed between two books with the tips of the forelegs on the one and with the end of the abdomen on the other. A very considerable weight for it, in the shape of some paper strips, has been placed on its abdomen, so that it is bent like a bow, and, notwithstanding, it will remain in the deepest catalepsy for one or more hours in this strange pose!

It is known that catalepsy has two distinguishing features: (1) a cataleptical subject does not feel pain: one may cut and sting him, and he remains in the same state of immobility; (2) the cataleptical tension of muscles does not cause fatigue. And, in fact, a cataleptical *Carausius* is completely feelingless: with sharp scissors one can cut off its antennae and feet, and, one after the other, all the segments of the abdomen; its green blood flows from the wounds, but it stays in the same pose completely motionless.

In order to awake the insect from its hypnotic sleep, a prolonged excitement of the nervous system is needed. One can excite it mechanically, for instance, by tweaking the end of its abdomen with forceps, or by giving it electrical shocks with an induction coil.

* *Zeitsch. f. wissensch. Insektenbiologie*, Bd. V, 1909, Heft 1–3.

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But the electrical shocks must be very strong: weak ones do not awake the insect.

The strangest circumstance in the catalepsy of *Carausius* is that this state arises from unknown *inner* conditions. If the insect is in its active state it is impossible to hypnotise it artificially, like a cray-fish. One can lay the creature down, fix it in a given position, stroke it gently, but nothing happens: it makes responsive movements, but does not become cataleptic. Only of its own accord and without exterior excitement does *Carausius* become so. Therefore, I have called this phenomenon "autocatalepsy."

From a biological standpoint the autocatalepsy is nothing more than an accommodation to a highly developed protective resemblance. A cataleptical *Carausius* is not only motionless but remains in the same position in which the external factors—for instance a breath of wind or a fallen twig or leaf—have placed it. Its likeness to the inanimate objects is increased and the insect is given an extra chance of surviving in the struggle for existence.

My laboratory experiments have detected also some interesting points in the physiology of the catalepsy of *Carausius* (which I have described elsewhere *), but biological observations on this feature under natural conditions are wanting. Perhaps some readers of "KNOWLEDGE" living in tropical countries will give some attention to this new question and make some observations on other Phasmidae. It is possible that the catalepsy is a feature of other representatives of this interesting family.

* *Biologisches Centralblatt*, 1913, *April*.

CORRESPONDENCE.

THE NUMBER OF DOUBLE STARS.

To the Editors of "KNOWLEDGE."

SIRS,—Mr. Bellamy is correct in stating that the number of double stars in Burnham's Catalogue is 13,665. I do not know how the number I gave came to be printed.

I hope you will let me remind him I found no fault with Mr. Lewis's Catalogue. I did not depreciate his work. I have no doubt Burnham would agree *his* work was incomplete, but Mr. Lewis's is much more so in point of numbers, and especially as it is only a reference catalogue for Struvian stars, and, of course, does not include the very numerous discoveries of Burnham, and is just as defective as regards spectroscopic binaries as Burnham's.

For the rest, Mr. Bellamy merely expresses his personal preference for Lewis's, and leaves my criticisms entirely untouched.

EDWIN HOLMES.

HORNSEY RISE, N.

SIRS,—By your courtesy I offer the following conclusions upon Mr. Holmes' reply.

1. Mr. Holmes' reply merely leaves the point unanswered—that is, the "Standard Authority" (or Catalogue)—which I take to be a work wherein the particular item required may almost certainly be found. On page 293 I stated enough to show that the Standard Catalogue of Double Stars (including Spectroscopic Binaries) is still, and may long be, a *desideratum*.

2. I demur to Mr. Holmes' statement that he found no fault with Mr. Lewis' Catalogue, for as the latter is a definite and complete piece of work, it would be nearly impossible to do so; but he most distinctly does this, by depreciation, on page 239.

3. The question of my personal opinion does not enter, as I dealt with facts; so the matter may end and Mr. Holmes may enjoy in print his original criticism on this point, which was of an inaccurate, spiteful, and unnecessary character. I have already proved the first; the second and third were too obvious. Personally, I may add that I have used Mr. Burnham's Catalogue some hundreds of hours more than that of Mr. Lewis, but not as a "Standard" Catalogue of Double Stars.

F. A. BELLAMY.

OXFORD.

STELLAR DISTANCE UNITS.

To the Editors of "KNOWLEDGE."

SIRS,—A. J. H. seems to have overlooked the fact that Kepler and Newton have each places assigned to them in the Moon, and when we think of the millions of worlds waiting to be named or numbered, there is no reason to be afraid that there will not be worlds to be christened, if necessary, after the earth's great men and women. A new name for "Light Year" was not asked for in June "KNOWLEDGE" as this is easy to understand, and simple enough. In these days of greater and more and more wonderful scientific researches and discoveries, when men are trying to measure "White Nebulae" and their distances, and so on, "Andromedes," "Sirio Meters," "Star Ratios," "Units" have been mentioned as measures of astronomical distances, so that there are now several astronomical measures of length; and when we try to think of the unmeasurable, unknown, infinitude of space, with all it contains, we may safely say, "More to follow."

A short easy word is needed to represent the nearest distance of the Earth from the Moon, and the second of arc now being divided into tenths, hundredths and thousandths, it is time some simple short words or signs were used for them.

J. W. SCHOLES.

"GRIMSCAR,"
HUDDERSFIELD.

SELBORNE EXTENSION LECTURES.

To the Editors of "KNOWLEDGE."

SIRS,—It is one of the difficulties of the Secretaries of local Scientific Societies and of Institutes to find, year after year, new subjects for discussion and lecturers whom their members have not previously heard. May I in this connection, therefore, call the attention of your readers to a list of lectures which I have compiled, and which is being printed in *The Selborne Magazine* for September. The various items have in most cases been delivered before the Selborne Society, and, in my capacity as Extension Lecture Secretary, I should be very glad indeed to give any help that I could to local Scientific Societies who are wanting good lectures of general interest, at fees which they can afford to pay. I may add that in certain cases the lecturers only wish to cover their expenses. The subjects, as befits the Society which perpetuates the memory of the author of "The Natural History and Antiquities of Selborne," deal with plants and animals, with the forces of Nature, and with Archaeology. Many of the lecturers have series of slides illustrating other addresses than those of which titles are given.

In places where there are no local bodies the Selborne Society, under special circumstances, would arrange one or more lectures, which would come under the category of Selborne Local Lectures.

PERCIVAL J. ASHTON.

42, BLOOMSBURY SQUARE,
LONDON, W.C.

CATALEPSY IN PHASMIDAE.

FIGURE 357.
Carausius as its sits on a branch.

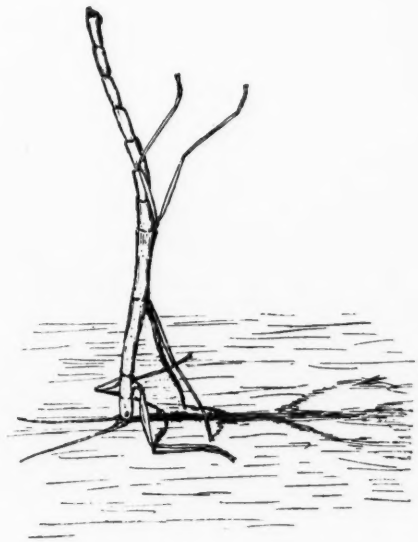

FIGURE 358.
Carausius morosus Br. v. W., standing on its head.

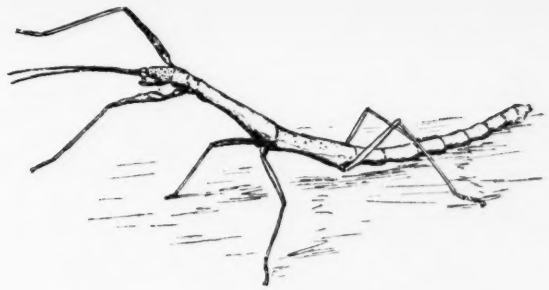

FIGURE 359. Mantis-like pose of *Carausius*.

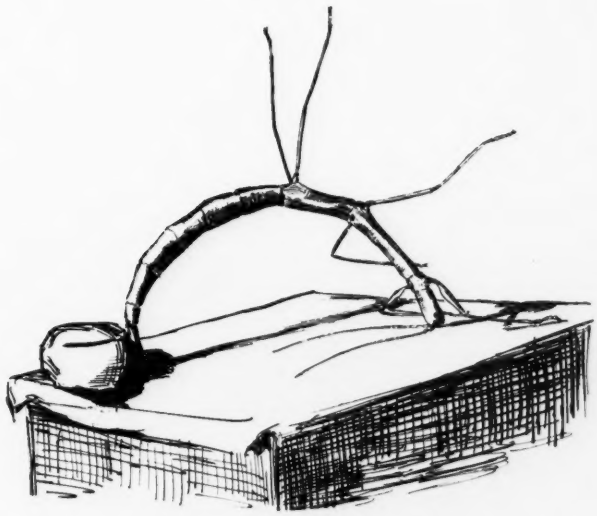

FIGURE 360. The "Wrestling Bridge."

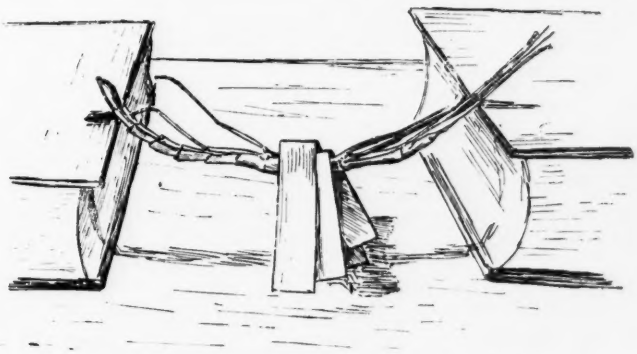

FIGURE 361. Hypnotic experiment with *Carausius*.

FIGURE 362. *Carausius* reclining.

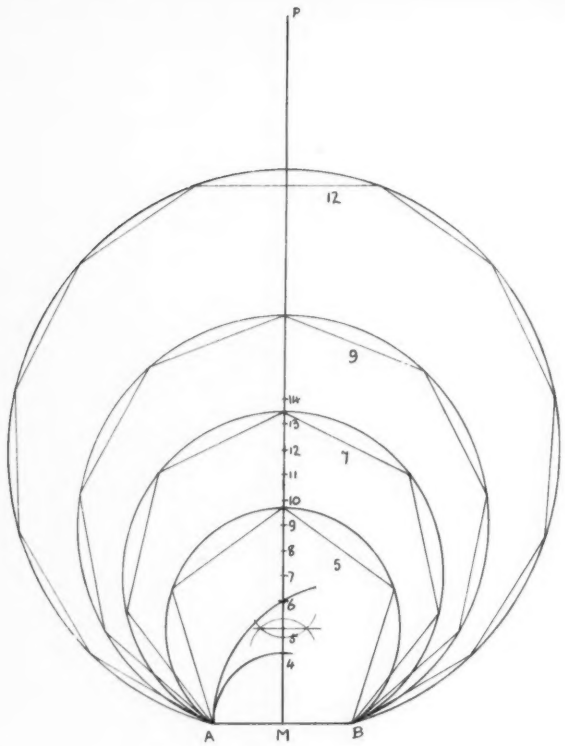

FIGURE 363.
First Method.

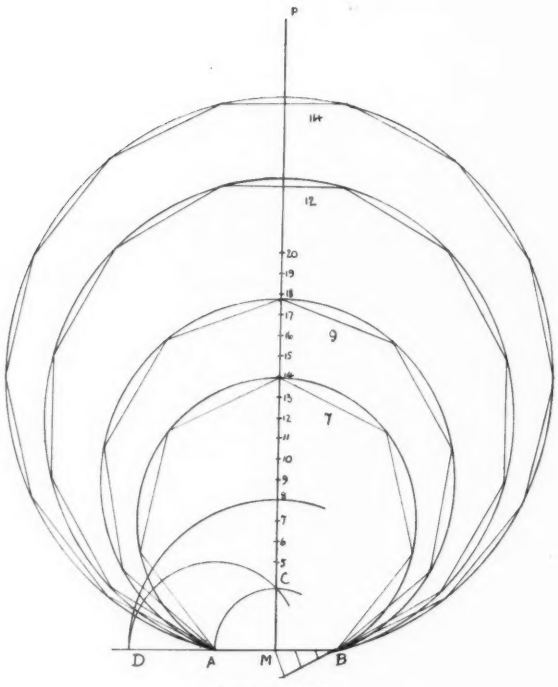

FIGURE 365.
Third Method.

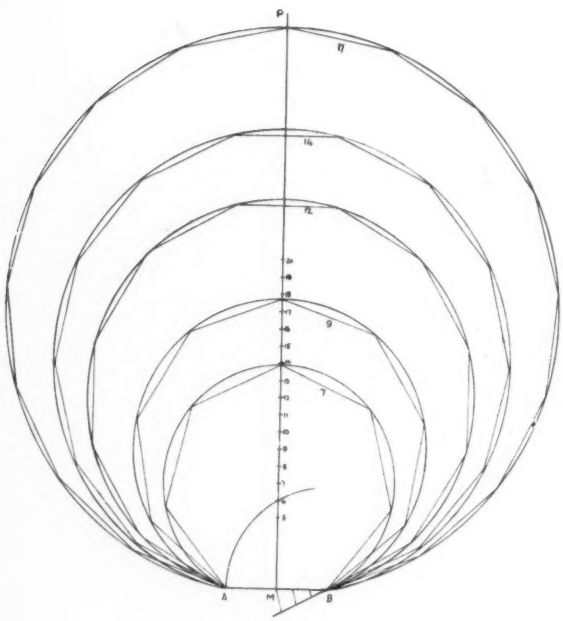

FIGURE 364.
Second Method.

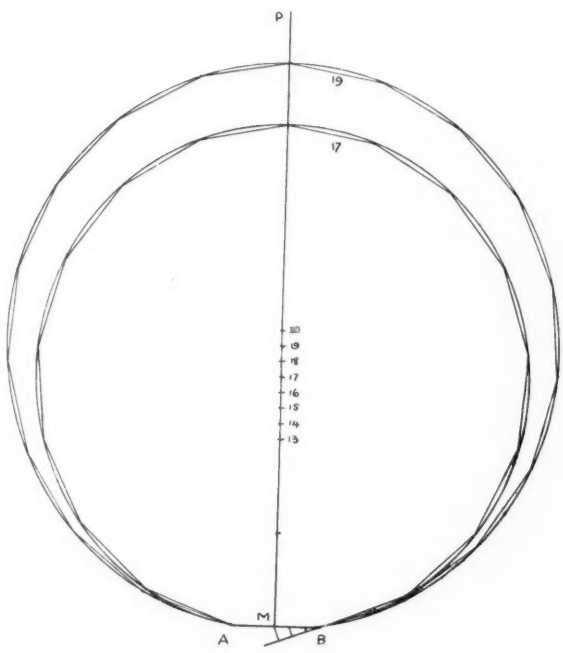

FIGURE 366.
Fourth Method.

Methods of Constructing Regular Polygons.

ON THE CONSTRUCTION OF REGULAR POLYGONS.

By H. STANLEY REDGROVE, B.Sc. (Lond.), F.C.S., and W. H. COLES.

There are simple well-known methods for constructing regular figures of 3, 4, 5, 6, and 8 sides of given length,* but the construction of regular polygons with 7 or more than 8 sides, the length of the sides being given, is a more difficult matter. There is a well-known method (which need not be described here) involving the division of a semicircle into as many equal parts as the polygon required is to have sides, which can be used with accuracy when the number of sides is either 2^n or 3×2^n (*i.e.*, 4, 8, 16, 32, and so on, or 6, 12, 24, 48, and so on), since the bisection of any arc and the trisection of a semicircle are both easily effected. When the number of sides, however, is any other number (*e.g.*, 7, 9, 10, 11, and so on), this method suffers under the disadvantage that the semicircle has to be divided by trial.

Another method is to calculate the vertical angle (θ) of the polygon by means of the formula

$$\theta = 180^\circ - \frac{360^\circ}{x},$$

where x is the number of sides; or the central angle (ϕ) may be calculated from the formula

$$\phi = \frac{360^\circ}{x};$$

either of these angles is then set out. In many cases, however, these angles are not measured by an exact number of degrees, and cannot, therefore, be accurately set out with an ordinary protractor. Moreover, when x is large, an increase of 1 or more to x produces very little alteration in the size of either θ or ϕ, so that the angles would have to be measured with extreme accuracy for the method to be any good. (See Table 58.)

The following method, though not new, does not appear to be very generally known. Let A B (see Figure 363) be one side of the required polygon. Bisect A B in M, and at M draw M P perpendicular to A B and of indefinite length. With centre M and radius M A (or M B) describe an arc cutting M P in 4. This point obviously gives the centre of the circle circumscribing the square drawn on A B as base. With centre B and radius B A describe an arc cutting M P in 6. This point obviously gives the centre of the circle circumscribing the regular hexagon drawn on A B as base. Bisect 46 in 5 and, commencing from 6, mark off divisions 7, 8, 9, 10, and so on, along 6 P, each equal to 45 or 56. Then each of these points gives, approximately, the centre of the circle circumscribing the regular polygon, drawn on A B as base, containing the same number of sides as the number used to designate the point. It is a simple matter, then, to draw the circle circumscribing the polygon desired, and to step distances equal to A B around its circumference. In Figure 363 are shown polygons containing 5, 7, 9, and 12 sides thus drawn. The first three are fairly accurate. The dodecagon, however, is not satisfactory, and the method is increasingly inaccurate as the number of sides is increased; for example, if one attempts to draw a fifteen-sided figure by this method, the result is a polygon with sixteen sides.

In the present paper we propose giving the results of an investigation of this method, which has made it possible to devise three similar, but far more accurate, methods, whereby regular polygons containing as many as twenty sides can be satisfactorily and easily drawn. In the above method it is assumed that the distances of the centres of the circumscribing circles from the mid-point of the given side are in arithmetical progression. Now, the length of this distance, in any case, measured in terms of half the side as unit, is obviously given by the tangent of half the vertical angle of the polygon, *i.e.*, $\tan\left(90^\circ - \frac{180^\circ}{x}\right)$, where x is the number of sides; thus in Figure 363, $\frac{6\,M}{A\,M} = \tan\left(90^\circ - \frac{180^\circ}{6}\right) = \tan\ 60^\circ = 1{\cdot}732$ (approx.). This method assumes, therefore, that $\tan\left(90^\circ - \frac{180^\circ}{x}\right)$ is a linear function of x. This is not actually the case, since

$$\frac{d \tan\left(90^\circ - \frac{180^\circ}{x}\right)}{dx} = \frac{\pi \sec^2\left(90^\circ - \frac{180^\circ}{x}\right)}{x^2},$$

i.e., a quantity whose value is not constant. This can also be seen from the figures given in Table 59. In column 2 are given the values of $\tan\left(90^\circ - \frac{180^\circ}{x}\right)$ between $x = 1$† and $x = 20$. In column 3 are

* There are also special methods for a few other polygons, but they are all tedious.

† No figures, of course, can be drawn corresponding to $x = 1$ and $x = 2$, but the values corresponding thereto are given throughout the table for the sake of completeness.

given the differences between consecutive values of $\tan\left(90° - \frac{180°}{x}\right)$. If $\tan\left(90° - \frac{180°}{x}\right)$ were a linear function of x, these would all be the same. This is evidently not the case, the difference tending to become less as x is increased. On the other hand, the differences do not vary very much after $x = 4$ is passed, and if the function $y = \tan\left(90° - \frac{180°}{x}\right)$ is graphed, the curve obtained does not differ very greatly from a straight line after the point corresponding to $x = 4$ is passed. (See Graph A, Figure 367.) The above method of drawing polygons gives the centres of the square and hexagon accurately; that is to say, this method gives $y = 1{\cdot}000$ when $x = 4$, and $y = 1{\cdot}732$ when $x = 6$. Since an equal increase in x (the number of sides to the polygon) produces an equal increase in y (the distance of the centre from the mid-point of the side) according to this method, it follows that $y = mx + c$, where m and c are constant quantities. Consequently

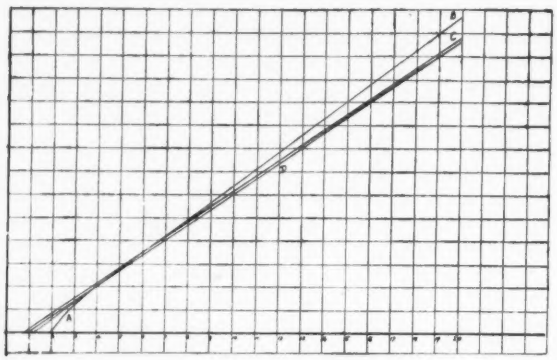

FIGURE 367.

$$4m + c = 1{\cdot}000, \text{ and } 6m + c = 1{\cdot}732,$$
$$\text{whence } c = -{\cdot}464, \text{ and } m = {\cdot}366.$$

Therefore $y = {\cdot}366x - {\cdot}464$. The values of y thus calculated are given in Column 4 of Table 59, and the differences between them and the true values of y (as given by $\tan\left(90° - \frac{180°}{x}\right)$), correct to the third decimal place, are shown in Column 5. As is evident, these differences are comparatively small between $x = 3$ and $x = 9$. After this they become increasingly large, as can also be seen by comparing the graphs of $y = \tan\left(90° - \frac{180°}{x}\right)$ and $y = {\cdot}366\,x - {\cdot}464$ (Graph B in Figure 367), so that this method, whilst fairly accurate for polygons with less than 10 sides, is not satisfactory when the number of sides exceeds 9.

The distance between consecutive centres is assumed in the above method to be ·366 × half length of side. Referring to Column 3 of Table 2, however, it is obvious that this difference, between $x=6$ and $x=20$, is more nearly equal to $\frac{1}{3}$ × half length of side. On this fact we base the three following methods, each of which has special advantages. We shall refer to the method discussed above as Method 1.

Method 2. Let A B (see Figure 364) be one side of the required polygon. Bisect A B in M, and at M draw M P perpendicular to A B, and of indefinite length. With centre B and radius B A describe an arc cutting M P in 6. This point obviously gives the centre of the circle circumscribing the regular hexagon drawn on A B as base (*i.e.*, $y = 1{\cdot}732$ when $x = 6$). Trisect M B (or A M) and, commencing from 6, mark off divisions 7, 8, 9, 10, and so on, along 6 P, each equal to $\frac{1}{3}$ M B. These points give the centres of the circumscribing circles. The polygons are then drawn as in Method 1. In Figure 366 are shown polygons containing 7, 9, 12, 14, and 17 sides thus obtained. The first four are very accurate, the last is affected by a slight error. The equation connecting x and y for this method can be obtained thus: Let $y = mx + c$. Then clearly

$$m = {\cdot}\dot{3}, \text{ and } 6m + c = 1{\cdot}732;$$
$$\text{whence } c = -{\cdot}268.$$

Therefore $y = {\cdot}\dot{3}x - {\cdot}268$. The values of y thus calculated are given in Column 6 of Table 59, and the differences between them and the true values of y are shown in Column 7. In no case between $x=4$ and $x=20$ does the difference exceed ·085, so that this method is a good method for any polygon containing 4 to 20 sides. In every case, moreover, save between $x=3$ and $x=5$ (which cases are not of importance), this difference is less than with Method 1. Method 2 is especially accurate when the number of sides is 11, 12, 13, 14, or 15. Graph C in Figure 367 represents the equation corresponding to $y = {\cdot}\dot{3}x - {\cdot}268$. It will be noticed how closely it lies to $y = \tan\left(90° - \frac{180°}{x}\right)$.

TABLE 58.

ANGLES OF REGULAR POLYGONS.

No. of Sides x.	Vertical Angle $\theta = 180° - \frac{360°}{x}$	Central Angle $\phi = \frac{360°}{x}$
3	60°	120°
4	90°	90°
5	108°	72°
6	120°	60°
7	128°34′ (approx.)	51° 26′ (approx.)
8	135°	45°
9	140°	40°
10	144°	36°
11	147° 16′ (approx.)	32° 44′ (approx.)
12	150°	30°
13	152° 18′ (approx.)	27° 42′ (approx.)
14	154° 17′ (approx.)	25° 43′ (approx.
15	156°	24°
16	157° 30′	22° 30
17	158° 49′ (approx.)	21° 11′ (approx.)
18	160°	20°
19	161° 3′ (approx.)	18° 57′ (approx.)
20	162°	18°

Method 3. Let A B (see Figure 365) be one side of the required polygon. Bisect A B in M, and at M draw M P perpendicular to A B and of indefinite length. With centre M and radius M A (or M B) describe an arc cutting M P in C. With centre A and radius A C describe an arc cutting B A produced in D. With centre M and radius M D describe an arc cutting M P in 8. It can be easily shown that this point is the centre of the circle circumscribing the regular octagon drawn on A B as base (*i.e.*, $y = 2{\cdot}414$ when $x=8$). Trisect M B (or A M) and, commencing from 8, mark off divisions 9, 10, 11, 12, and so on, along 8 P, and 7, 6, 5 along 8 M, each equal to $\frac{1}{3}$ M B. These points give the centres of the circumscribing circles. The polygons are then drawn as in the former methods. In Figure 365 are shown polygons containing 7, 9, 12, and 14 sides thus obtained. The first three are very accurate; the last is affected by a slight error. The equation connecting x and y for this method can be obtained thus: Let $y = mx + c$. Then clearly

$$m \cdot\dot{3}, \text{ and } 8m + c = 2{\cdot}414;$$
$$\text{whence } c = -{\cdot}\dot{2}53.$$

Therefore $y = \cdot\dot{3}x - \cdot\dot{2}53$. The values of y thus calculated are given in Column 8 of Table 59, and the differences between them and the true values of y are shown in Column 9. In every case after $x=6$, these differences are less than with Method 1; but after $x=10$ they are greater than with Method 2. For polygons containing 7, 8, 9, or 10 sides this method is the most accurate. The graph of the equation $y = \cdot\dot{3}x - \cdot\dot{2}53$ cannot be shown distinct from that of $y = \cdot\dot{3}x - \cdot 268$ in Figure 367, since the two lines practically coincide.

TABLE 59.

1	2	3	4	5	6	7	8	9	10	11
x	$\tan\left(90^\circ - \frac{180^\circ}{x}\right)$	Differences.	Method 1.		Method 2.		Method 3.		Method 4.	
			$\cdot 366x - \cdot 464$	Errors.	$\cdot\dot{3}x - \cdot 268$	Errors.	$\cdot\dot{3}x - \cdot\dot{2}53$	Errors.	$\cdot\dot{3}x - \cdot\dot{3}$	Errors.
1	$-\infty$		$-{\cdot}098$	—	$+{\cdot}065$	—	$+{\cdot}080$	—	0	—
2	0	$+\infty$	$+{\cdot}268$	—	·399	—	·414	—	$+{\cdot}333$	—
3	$+{\cdot}577$	·577	·634*	$+{\cdot}057$	·732	$+{\cdot}155$	·747	$+{\cdot}170$	·667	$+{\cdot}090$
4	1·000	·423	1·000*	·000	1·065	·065	1·080	·080	1·000*	·000
5	1·376	·376	1·366*	$-{\cdot}010$	1·399	·023	1·414	·038	1·333	$-{\cdot}043$
6	1·732	·356	1·732*	·000	1·732*	·000	1·747	·015	1·667	·065
7	2·076	·344	2·098	$+{\cdot}022$	2·065	$-{\cdot}011$	2·080*	·004	2·000	·076
8	2·414	·338	2·464	·050	2·399	·015	2·414*	·000	2·333	·081
9	2·747	·333	2·830	·083	2·732	·015	2·747*	·000	2·667	·080
10	3·078	·331	3·196	·118	3·065	·013	3·080*	·002	3·000	·078
11	3·406	·328	3·562	·156	3·399*	·007	3·414	·008	3·333	·073
12	3·732	·326	3·928	·196	3·732*	·000	3·747	·015	3·667	·065
13	4·057	·325	4·294	·237	4·065*	$+{\cdot}008$	4·080	·023	4·000	·057
14	4·381	·324	4·660	·279	4·399*	·018	4·414	·033	4·333	·048
15	4·705	·324	5·026	·321	4·732*	·027	4·747	·042	4·667	·038
16	5·027	·322	5·392	·365	5·065	·038	5·080	·053	5·000*	·027
17	5·349	·322	5·758	·409	5·399	·050	5·414	·065	5·333*	·016
18	5·671	·322	6·124	·453	5·732	·061	5·747	·076	5·667*	·004
19	5·993	·322	6·490	·497	6·065	·072	6·080	·087	6·000*	$+{\cdot}007$
20	6·314	·321	6·856	·442	6·399	·085	6·414	·100	6·333*	·019

Method 4. Let A B (Figure 366) be one side of the required polygon. Bisect A B in M, and at M draw M P perpendicular to A B and of indefinite length. Now, when $x=19$, $\tan\left(90°-\frac{180°}{x}\right)=6.$ almost exactly; so that if a point 19 be marked on M P distant from M three times the length of A B, this will give very accurately the centre of the circle circumscribing the regular nonadecagon drawn on A B as base. Mark this point. Trisect M B (or A M) and, commencing from 19, mark off divisions along M P each equal to $\frac{1}{3}$ M B. These points give the centres of the circumscribing circles. The polygons are then drawn as in the former methods. In Figure 366 are shown polygons containing 17 and 19 sides thus obtained. Both are extremely accurate. The equation connecting x and y for this method can be obtained thus: Let $y=mx+c$. Then clearly

$$m = \cdot\dot{3}, \text{ and } 19m + c = 6\cdot000;$$
$$\text{whence } c = -\cdot\dot{3}.$$

Therefore $y = \cdot\dot{3}x - \cdot\dot{3}$. The values of y thus calculated are given in Column 10 of Table 59, and the differences between them and the true values of y are shown in Column 11. Below $x = 15$, these differences are higher than with Methods 2 and 3, and below $x = 9$ they are greater than with Method 1. This method is not recommended, therefore, for polygons with less than 15 sides. But when the number of sides lies between 15 and 20 inclusive, it is the most accurate method. The graph of the equation $y = \cdot\dot{3}x - \cdot\dot{3}$ is shown in Figure 367 (Graph D). It practically coincides with that of $y = \tan\left(90° - \frac{180°}{x}\right)$ between $x = 16$ and $x = 20$.

We have not considered it necessary to continue the investigation for polygons containing more than 20 sides, though doubtless similar methods for accurately constructing such polygons could be devised.

In Table 59 that method which is most accurate for each polygon is indicated by an asterisk. If, when using any of these methods, one has a list of errors, such as given in Columns 5, 7, 9, and 11 of Table 59, an even more accurate construction may be obtained by estimating with the eye the true position of the centre of the circumscribing circle above or below the approximate position given by the method employed.

SOLAR DISTURBANCES DURING JULY, 1913.

By FRANK C. DENNETT.

DURING July the solar disc has shown very little disturbance, though rather more than in the two previous months. On eight days (2, 5, 19, 21, 22 to 24 and 27) the disc appeared quite clear. On nine (7 to 14 and 30) spots or pores were visible. No observations were made on the 18th, and on the remaining thirteen days faculae were visible. The longitude of the central meridian at noon on July 1st was 137° 20′.

No. 9.—First seen on the 9th as two spotlets, the larger leading. On the 10th there were at least three umbrae in the western portion of the group and two, with a dull companion, in the eastern. The disturbance reached its maximum on the 11th, being some 40,000 miles in length; the components were smaller on the 12th, and less in the evening than in the morning. Only two pores were seen on the 13th, one still remaining on the 14th. Faculae were seen in the same area on the 16th and 17th.

No. 10.—A little group of pores seen on the morning of the 30th, which had faded greatly by the afternoon, and were gone entirely by the next day.

On both the 7th and 8th tiny black pores and bright flecks were visible in various places on the disc under best conditions, but none sufficiently conspicuous to measure.

Faculae during the month were very far from being conspicuous. There were some near the western limb on the 1st, and within the north-eastern on the 3rd and 4th. On the 20th a facula near longitude 295°, S. Latitude 35°, was approaching the south-western limb. Faculae were within the eastern limb on the 25th and 26th, also within the north-eastern limb on the 28th and 29th. On the 29th faculae were also situated at about 206°, 20° North, and 56°, 5° South. There were faculae near the eastern limb on the 31st.

Our chart is constructed from the combined observations of Messrs. J. Mc Harg, A. A. Buss, E. E. Peacock, W. H. Izzard and F. C. Dennett.

DAY OF JULY, 1913.

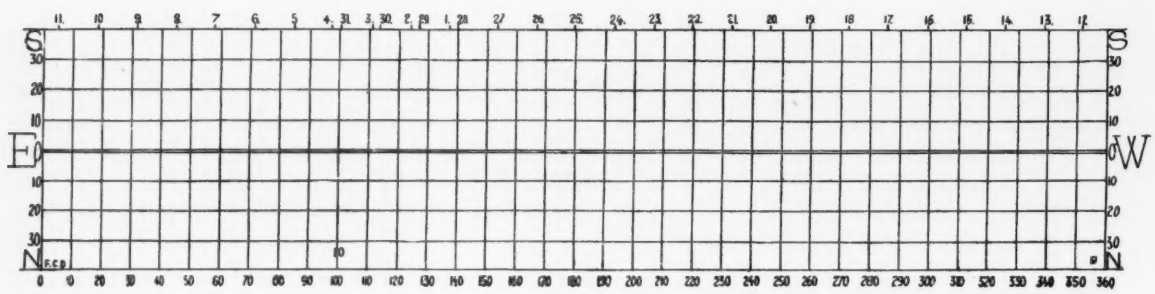

FIGURE 368.
Nest of the Song Thrush built against a post and lacking one side.

FIGURE 370.
An old pail in which a Blackbird annually builds.

FIGURE 369.
A Song Thrush sitting in an old Kettle.

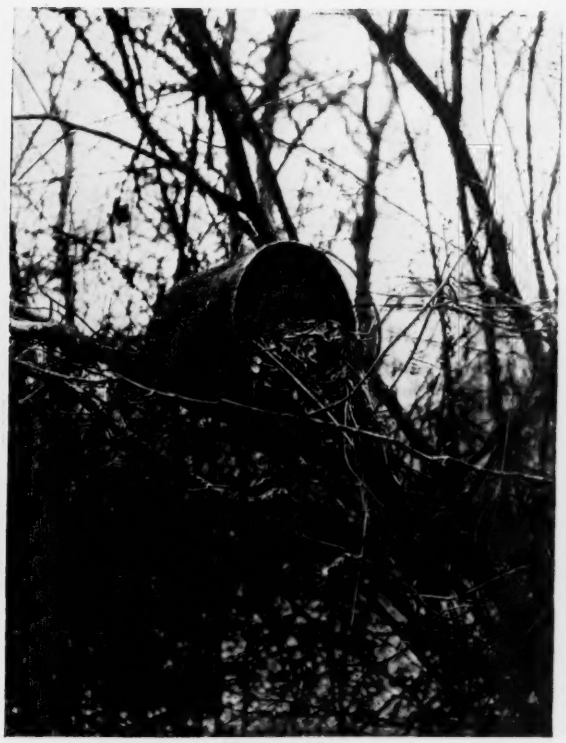

FIGURE 371.
A Blackbird's nest in an old paint pot.

XUM

FIGURE 372.
A Song Thrush's nest on the top of a nesting box in which tree sparrows built.

FIGURE 374.
A Song Thrush's nest built in an open bracket basket put up for the purpose.

FIGURE 373.
The nest of a Blackbird built in an open-fronted nesting box intended for robins and flycatchers.

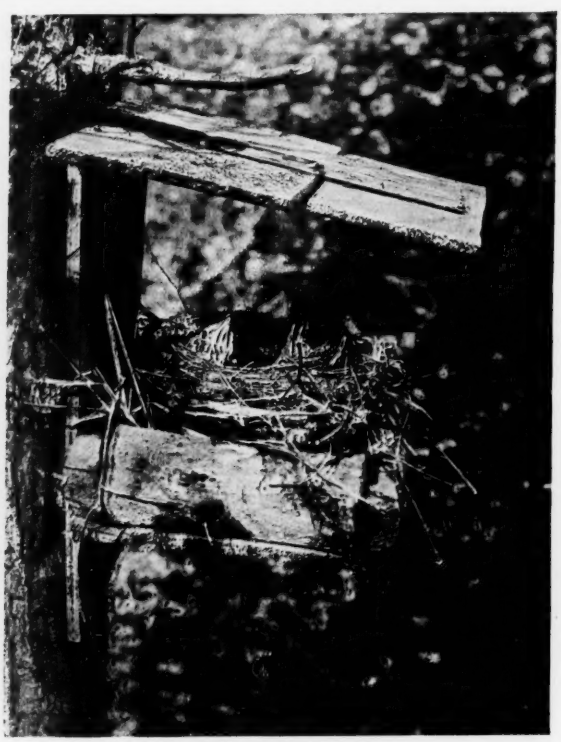

FIGURE 375.
Young Song Thrushes in a nest built on a roofed tray made for these birds or blackbirds.

THE NESTS OF THE SONG THRUSH AND BLACKBIRD.

By WILFRED MARK WEBB, F.L.S.

Chairman of the Brent Valley Bird Sanctuary Committee.

MANY of the blackbirds and thrushes which nested in the Brent Valley Bird Sanctuary during the past spring and summer built in interesting positions, and a short account of a few of the sites will be given here.

The first nest to which we may allude was that of a song thrush which was built against a flat-sided post about two feet from the ground. The interesting part about the structure, however, is that there was practically no material used on the side towards the post, but it appeared as shown in Figure 368. The hollow was therefore not circular and the nest recalled that of a martin, which is built against a wall.

In connection with the height of this nest from the ground, it may be mentioned that both blackbirds and thrushes have at various times actually placed their nests directly on the earth, though until the year 1912 it was noticed that the birds were usually unsuccessful in rearing their young. In that year, however, a song thrush which constructed a well-hidden nest under some brambles, brought up five young ones, and this spring four young birds flew from a very similar nest which probably belonged to the same old birds.

Our second illustration (see Figure 369) shows one of the same kind of bird sitting in an old kettle which in previous years has found favour with robins and with wrens. Blackbirds have chosen a similar nesting-place in the Sanctuary, but this is the first time that a thrush has contented itself with such restricted accommodation. The hen bird, it may be mentioned, like others which have chosen artificial surroundings, was very tame, and when perching on the branch outside the kettle would allow us to stand within a couple of feet of it.

Four or five years ago an old pail was lodged in the fork of a large hazel branch, and during successive seasons since blackbirds have built in it, sometimes rearing two broods of young ones (see Figure 370). Another pair of these birds built a very substantial nest in the disused paint pot which is seen in Figure 371. But some enemy or other interfered with the eggs and the nest was deserted.

Some years ago a thrush took possession of the top of one of the rough closed nesting boxes with a sloping roof put up for smaller birds, and completed its work of building in a little over a week, but the nest slipped off the box and came to grief. This year, two nests were found in similar positions and these remained quite steady, tree sparrows taking possession of the insides of the boxes. One of the nests is shown in Figure 372, and the box is becoming quite an historical one. It was occupied by the first pair of nuthatches which were recorded as breeding in the wood, a wryneck has laid in it, as well as tits and tree-sparrows.

Quite close at hand, another thrush brought off her brood on the top of a hurdle inside the shed in which the keeper was at work.

For the benefit of robins and flycatchers nesting boxes made of hazel branches with open fronts have been put up, and on two or three occasions have been taken possession of by blackbirds, with complete success. One of these, which was occupied during the past summer, is shown in Figure 373. Once or twice song thrushes have begun operations in similar receptacles, but they have not completed their work, probably because there is too little room, and as they twist round in nest-building their tails catch against the sides of the box.

Seeing that blackbirds and thrushes will take to artificial nesting-sites such as have been mentioned, and that bird lovers who were anxious for these birds to nest with some amount of security in their gardens had made enquiries, members of the Bird Sanctuary Committee were led to try the experiment of making special arrangements for these birds. Both species very commonly build on the small twigs that grow out from the lower parts of tree trunks, and trays and baskets were made of thicker or thinner branches and nailed up like brackets in their positions, as well as flat trays, which were nailed on the upper sides of horizontal branches. Very few of the latter were used, but as the others became weathered and the artificial look wore off, they came to be occupied more and more generally, until this year probably ten or a dozen were used.

The first one of which use was made some time ago was of the type shown in Figure 375, where the trays were fastened to a board and supplied with a roof of the same material. This covered bracket tray forms a very snug nesting site and during the winter a field-vole made a roof of moss to the deserted nest, and bored a small round hole in the mud lining, making himself very cosy winter quarters. In Figure 375, just mentioned, some young thrushes of this year can be seen.

Another type of bracket is similar to the last described, but instead of having at the back boards and a roof, the tray is simply fastened to two vertical pieces of split branch, the flat sides being put against the tree and those with the bark on away from it. Still yet another kind resembles the baskets which are made for ferns. This is shown in Figure 374 and contains

a thrush's nest and eggs. A blackbird's nest in a similar basket was begun on a Tuesday and was seen completed with two eggs in it on the following Sunday morning, while it may be added in this connection that within two days of a new log box being put up a great tit had begun to bring in material, and before the week was out the nest was finished and contained eggs.

Some seasons ago, two examples of the Lyne nesting bush, which we believe is intended for aviaries, were sent to the Sanctuary by the inventor, and one of these put up in a hazel was occupied by a thrush in the first year, but not afterwards. We have pretty well exhausted the various places which the birds with which we are dealing have chosen in the Sanctuary, but we may mention that in *The Selborne Magazine* for August a photograph is reproduced showing a ladder hanging under the eaves of a cottage with thirteen blackbirds' nests built between the rungs. These were constructed in the same season, and several of the birds were sitting at the same time.

NOTES.

ASTRONOMY.

By A. C. D. CROMMELIN, B.A., D.Sc., F.R.A.S.

PROFESSOR NEWCOMB'S LAST RESEARCHES ON THE MOON'S MOTION.—A pathetic interest attaches to the volume of the American Ephemeris Papers that has lately appeared; for Professor Newcomb, who had given a large portion of his life to researches on the Moon's motion, and was the first to find the reason of the rapidly growing error of Hansen's Tables, continued to dictate the matter of the present volume till within a few days of his death. Some thirty years have now passed since his earlier researches, in which he showed that one of Hansen's large Venus terms ought to be left out altogether, having no place in theory; that the mean motion and secular acceleration he used were also wrong, and that it was necessary to introduce a large empirical term with a period of about three centuries. These four alterations were introduced into the *Nautical Almanac* under the name of Newcomb's Corrections, and are used there to this day. There were some who denounced their introduction, which they called an introduction of empiricism into exact astronomy; this shewed a decided misconception of the situation; only one of Newcomb's four corrections was empirical, the others were in accordance with theory; besides, Hansen's Tables were themselves just as empirical, for they had a large Venus term which ought not to be there at all, its coëfficient being really quite insensible. In the last thirty years many attempts have been made to find a theoretical explanation of the great empirical term. It is now established that it cannot be due to the action of any of the known planets; at least four causes have been suggested: it might be due to a ring of planets inside Mercury's orbit, with period nearly the same as a lunation; or to want of symmetry in the sun, whose rotation is nearly the same in length as a lunation (this suggestion was made by Brown, but it does not appear tenable in view of the great differences of rotation-time of different zones of the sun); or that gravity was obstructed in passing through matter, so that a lunar eclipse causes a diminution in the sun's action on the moon (this is due to Dr. de Sitter); or that there is some connection with the earth's magnetism, the period of revolution of the magnetic pole being something like three centuries.

The object of Professor Newcomb's last research was to try to find the nature of the great oscillation with more accuracy; for this purpose he has used a very long series of observations of occultations of stars; these are capable of more precision than meridian observations, for the disappearance or reappearance is instantaneous, and can be estimated to a quarter of a second or less. The places of all the brighter stars in the zodiacal region have now been found fairly accurately, and the error of the moon's place can be deduced. I would remark that the observation of these phenomena is one in which amateurs may well take part; a three-inch telescope is amply large enough; there must be some means of getting correct time; one way of doing this is to receive the wireless signals from the Eiffel Tower. Writers in *Nature* have stated that they have succeeded in doing this, using an ordinary wire mattress as collector; a fairly good clock or chronometer is also necessary, to measure the interval between the occultation and the time signal.

After calculating the results given by the long series of occultations, which extend from 1620 to 1908, Newcomb proceeds to discuss the mean motion and acceleration, and the form of the empirical fluctuation. He finds that a single sine curve will not represent the fluctuation; there is evidence of another with a period of about sixty-four years, which has, in fact, been introduced into the new French Tables; the great term is best represented by the expression

$$12''\cdot95 \sin \left\{ 1^\circ\cdot31\,(t-1800) + 100^\circ\cdot6 \right\}$$

the period being two hundred and seventy-five years; his result of thirty years ago was

$$15''\cdot49 \sin \left\{ 1^\circ\cdot3187\,(t-1800) + 93^\circ\cdot9 \right\}.$$

The coëfficient has now been reduced by $2\frac{1}{2}''$, and the period lengthened by four years.

Newcomb gave a diagram of the fluctuations of the moon from its calculated place since 1620 in the *Monthly Notices* for January, 1909; it clearly shows the great wave and the term of about sixty-four years, and there is an appearance of a still shorter wave from the observations of the last century.

The work also discusses ancient eclipses of sun and moon; Newcomb gives little weight to the former, considering that the evidence that any eclipse was total at a given point is not convincing; indeed, this is admitted by all, and weight is only assigned to corrections which will make most of the eclipses of antiquity agree with the narratives.

Several other astronomical constants are incidentally discussed, since this long series of occultations throws light on them: among others the rate of change of the obliquity of the ecliptic; Newcomb favours Seeliger's suggestion that we should look to the denser part of the Zodiacal Light for an explanation of the discordance of this rate from theory, also of discordances in the rate of motion of the perihelion of Mercury and of the node of Venus (Newcomb had deduced $8''\cdot76$ for the sun's parallax from the motion of Venus' node; the accepted value now is $8''\cdot806$; the discordance may be due to the action of the Zodiacal Light). The part of the Zodiacal Light that seems to be gravitationally active is of ellipsoidal form, and within the orbit of Mercury; that is, it is only a small part of the light that we see, but the density doubtless increases rapidly as we approach the sun, so that most of the mass lies inside Mercury's orbit. This would be a more satisfactory explanation than the assumption that gravity does not vary exactly as the inverse square. Another suggestion for explaining the anomalies in the moon's motion was that they might arise from changes in the rate of the earth's rotation. Newcomb tested this question by the observed transits of Mercury; his earlier discussion seemed to indicate changes that would explain half the moon's fluctuations; but the more complete discussion seems to indicate no change in the rotation rate. The rather unsatisfactory end of the entire work is that "Until the matter is

cleared up it will be impossible to predict the moon's longitude with the precision required for astronomical purposes. We shall be obliged to correct the moon's mean longitude from time to time, perhaps at intervals of ten to twenty years from observation."

THE MAGNETIC FIELD OF THE SUN.—*Nature* for July 17th contains an interesting article on Professor Hale's recent work in this direction. It will be remembered that the hydrogen vortices round sunspots gave evidence by the Zeeman effect (*i.e.*, the doubling or tripling of spectral lines) of the passage of the rays through a magnetic field, which it was reasonable to conclude was caused by the whirling motion of negative electrons. The present investigation has been a search for a similar but much weaker effect due to the general magnetic field of the sun. Great dispersion is required, as the field is weak, and the Zeeman effect slight; the new 164-feet tower telescope and 75-feet spectrograph at Mount Wilson have been used, which make one Angström = 4·9 millimetres; the distance between the D lines is 29 millimetres, or over an inch. Full details are given in *Nature* of the manner of taking and measuring the spectrograms. It will suffice to say here that the spectrograms are divided into narrow longitudinal strips, polarised in opposite directions, so that alternate members of the doublets appear on alternate strips, and the lines as a whole have an "in-and-out" appearance. The shifts follow a sine-curve fairly regularly, being 0 at the equator and poles, and reaching maxima in opposite directions at latitude 45° north and south. The maximum displacement in either direction is about ·006 millimetres. It is concluded that the north magnetic pole of the sun lies at or near the north pole of rotation, and that the strength of field at the pole is about fifty Gausses. The lines belonging to high levels of the sun's atmosphere show practically no displacement, so it is concluded that the field falls off rapidly as we ascend from the photosphere. It is incidentally suggested that the tiny pores, which appear at all parts of the sun, are incipient vortices which, under favourable conditions, develop into spots. The whole investigation is a striking illustration of the power of modern methods, especially in the hands of such a master as Professor Hale. He contemplates further researches, so as to obtain more information as to the variation of the magnetic field at different altitudes.

BOTANY.

By PROFESSOR F. CAVERS, D.Sc., F.L.S.

INDIAN TIMBER TREES.—The Superintendent of Government Printing, Calcutta, is issuing a series of extremely useful notes on Indian timbers (Forest Bulletins, Nos. 16 to 21, price 4d. each), which can be obtained from H. S. King & Co., 65, Cornhill, London; Oliver & Boyd, Tweeddale Court, Edinburgh; E. Ponsonby, 116, Grafton Street, Dublin; or through any bookseller. The trees dealt with in the six bulletins just issued are, respectively, *Gmelina arborea*, *Pterocarpus marsupium*, *Terminalia tomentosa*, *Lagerstroemia lanceolata*, *Ougeinia dalbergoides*, and *Anogeissus latifolia*. Each bulletin gives the distribution, habit, and so on, of the tree, the properties and uses of the timber, minor products, if any, and much other information, and includes a specimen of the wood in the form of a thin section mounted in a stout cardboard frame. The preparation of these bulletins, and their issue at such an extremely low price, reflect the greatest credit on the enterprise of the Forest Research Institute at Dehra Dun, the officers of which are responsible for their compilation, and it would be a great boon were our home authorities to issue a similar set of notes on British-grown timbers.

THE FAMILY HYDROPHYLLACEAE.—In the great encyclopaedia of systematic botany, "Das Pflanzenreich," now being issued under the editorship of Professor Engler, there has just appeared a monograph of the family Hydrophyllaceae, by A. Brand (Heft 59, 210 pages. Price M. 10.60). Though some members of the family are cultivated as border plants (chiefly species of *Nemophila* and *Phacelia*), the Hydrophyllaceae are not represented in Europe, and though some species occur in all the other continents the great majority are American, and the family is practically concentrated in California and adjacent parts of North America. In several respects the family is one of the most interesting among the gamopetalous Dicotyledons. The geographical distribution of the genera and species presents some remarkable features, which can only adequately be explained on the view that the distribution was formerly much more extensive than at the present day; the few species which occur outside of North America—in South America, tropical Asia, Africa, and so on—appear to be remnants of former widespread genera. The systematic position and the affinities of the Hydrophyllaceae are also of great interest. The family is placed near the base of the Tubiflorae—the large series of Gamopetalae including such families as Convolvulaceae, Solanaceae, Scrophulariaceae, Labiatae, and so on. To the Boraginaceae it presents various resemblances, such as the roughly hairy leaves and stems, the coiled inflorescence (the so-called "scorpioid cyme"), the presence in various forms of scales within the mouth of the corolla-tube, and the internal anatomy; as to the last point, the family agrees with Boraginaceae and Polemoniaceae in having collateral bundles of the normal type instead of bicollateral bundles with internal phloem such as occur in the Convolvulaceae and Solanaceae. Again, the family is separated somewhat widely from the Polemoniaceae by the fact that the micropyle of the seed is directed upwards (as in the Boraginaceae), while the structure of the ovary in Hydrophyllaceae differs from that of all the neighbouring families owing to the characteristic large placentas, which only rarely fuse in the centre so as to produce a truly two-celled ovary—in most cases the placentation is parietal. Yet there is a striking correspondence between Hydrophyllaceae and Polemoniaceae as regards geographical distribution. During the twenty years that have elapsed since the Hydrophyllaceae were dealt with in Engler and Prantl's "Pflanzenfamilien," the number of known species has increased from one hundred and seventy to two hundred and thirty. Like all the other volumes of "Das Pflanzenreich," this monograph is more than a mere technical description of genera and species, the systematic portion being preceded by an interesting general account of the anatomy, pollination mechanisms, geographical distribution, affinities, and so on.

BIOLOGY OF SUBMERGED WATER-PLANTS.—An interesting resumé of various recent publications on the structure, physiology, and ecology of aquatic and marsh plants is given in the current number (Vol. I, No. I, June) of the new *Journal of Ecology*. One of the papers reviewed at considerable length is by W. H. Brown (*Philippine Journal of Science*, Vol. VIII), and deals with the relation of the substratum to the growth of the Canadian water-weed, *Elodea* (*Anacharis*) *canadensis*, though the results have a general bearing upon the biology of submerged water-plants. Brown gives tables showing the relative growth of *Elodea* with and without the addition of carbon dioxide to the water, in tap water, and in Knop's nutrient solution, with and without soil, rooted in and simply anchored over soil or sand, and so on, and the results from this portion of his work are summarised as follows:—Sufficient carbon dioxide to keep the plant growing or even alive does not diffuse from the air into the water during winter and spring; the substratum probably serves as an important source of this gas. The *Elodea* is not dependent on its roots for absorption of mineral salts; the chief function of the roots (in this and doubtless in other submerged rooted aquatics) is to anchor the plant to the soil, which is advantageous when the soil contains organic matter and gives off carbon dioxide; plants rooted in good soil grow better than those simply anchored over the same soil. When carbon dioxide was supplied by a generator instead of by the soil, rooted and anchored plants grew about equally well; with similar soils but no external supply of carbon dioxide, floating plants grew better than rooted ones, the air being in this case the source of carbon dioxide.

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Further details of Brown's important work, and of various other recent researches on the interesting aquatic flora of ponds and streams, are given in the review mentioned above, which extends to nine pages and deals with every important publication on the aquatic and marsh flora during the last two years, with references to earlier work in addition.

CUSHION PLANTS.—Another interesting article in the *Journal of Ecology* for June deals with the structure, physiology, and ecology of cushion-plants, based on an important work by Hauri (*Beih. Bot. Centralbl.*, Band 28), of which the following is a brief summary. Cushion plants are perennial, usually evergreen, more or less stunted plants of compact and usually rounded growth and dense branching, the branches being closely covered with relatively small stiff sessile leaves which are either appressed or are packed together with hairs. Hence the plant forms a living spongy cushion characterised by firmness, compactness, and closed growth, which reäcts as a whole to the factors of the environment. Details are given of the main features of these remarkable plants, under such headings as general form, branching, root system, firmness and closure, and packing material, and cushion-plants are divided into six classes (illustrated by a full-page set of illustrations) of which examples are given. In the general sketch of the biology and ecology of cushion-plants the following points are noted. (*a*) The capacity for absorbing and retaining large quantities of water, serving to regulate the temperature of the plant during alternate warming and cooling of the air, to keep the air in and around the plant relatively moist, to make the underlying soil moist and warm, and in some cases to supply water directly to the aërial organs by means of adventitious roots. (*b*) The crowding and overlapping of the leaves, serving as a protection against direct insolation, and producing wind-still and moist capillary interspaces between the branches, thus minimising loss by transpiration. (*c*) The compact growth of the branches in the cushion, which enhances the capillary arrangement due to (*b*) and serves to collect sand and other wind-borne débris as well as the dead leaves of the plant itself, besides being the main factor in producing the cushion habit itself with its obvious protective advantages. (*d*) The packing material, which enormously enhances the water-holding capacity of the cushion, provides food in the form of humus, and enhances the rigidity and hardness of the cushion. The degree of hardness attained in some cases may be judged from the fact that in some Andine species, such as *Azorella madreporica*, the plant turns off a revolver shot at point-blank distance, and specimens can only be obtained by breaking up the cushion with a hammer!

CHEMISTRY.

By C. AINSWORTH MITCHELL, B.A. (OXON), F.I.C.

WILD LETTUCE RUBBER.—Mr. C. R. Fox, writing in the *Journ. Ind. Eng. Chem.* (1913, V, 477), gives an account of two species of wild lettuce which grow in the United States, and suggests the possibility of utilising them for the production of rubber. One of these, *Lactuca canadensis*, which is popularly known as "trumpet weed," yields when bruised a thick milky juice, or latex, containing over two per cent. of rubber. It also contains upwards of 13 per cent. of a brittle brown resin, which dissolves readily in alcohol and acetic acid, and a slightly acid substance with an intensely bitter taste. More than forty years ago it was stated by Maisch that the juice of this lettuce contained a bitter principle, "lettuce opium," and Mr. Fox suggests that extraction of this drug combined with the separation of the rubber might be found a profitable industry. Owing to the presence of the acid bitter principle the rubber would require washing with alcoholic alkali.

The other species of lettuce, *L. scariola*, is an annual plant, the juice of which contains less rubber (1·58 per cent.) and a smaller proportion of resin. The rubber derived from either of these plants is stated to possess excellent physical properties.

ACTION OF CAUSTIC LIME ON SOIL. — It is common knowledge that soil is materially improved by suitable additions of caustic lime, and this is usually attributed to its neutralising the free acids in the soil and rendering the plant food constituents suitable for absorption by the plant. Mr. H. B. Hutchinson's experiments, however (*Journ. Agric. Science*, 1913, V, 320), indicate that these effects do not explain the whole of the results obtained in practice through the application of lime to the soil. The germicidal action of the lime is a material factor, and it has been found that its action in this direction is more pronounced than that of volatile antiseptic agents, but is less effective than sterilising the soil by heat. The immediate effect of adding lime is to destroy the larger protozoa and a large proportion of the bacteria in the soil, and to decompose organic nitrogenous compounds. After the whole of the lime has been transformed into carbonate bacteria begin to develop rapidly, and there is an increase in the production of available plant foods.

These conclusions were confirmed by the results of practical tests with different soils. For example, the addition of 0·5 per cent. of caustic lime to a poor soil already containing sufficient calcium carbonate was followed by a pronounced increase in the crops; while treatment of a good garden soil with varying proportions of caustic lime up to 1 per cent. caused the first crop to be poorer, but the second crop to be much richer than originally.

THE ACTIVE MODIFICATION OF NITROGEN.—It has been asserted that the phenomena attributed to active nitrogen are due to the presence of traces of oxygen, but the Hon. R. J. Strutt shows (*Proc. Royal Soc.*, 1913, A. LXXXVIII, 539) that this is not the case. On the contrary, oxygen has an unfavourable effect, and when present in the proportion of two per cent. inhibits the reäctions of the nitrogen. In preparing the nitrogen for the action of the electric discharge, Mr. Strutt absorbs all traces of oxygen by means of phosphorus, and then dries the gas by passing it first through phosphorus pentoxide and then through a tube packed with copper gauze and cooled with liquid air. Finally, oxides of phosphorus are dissolved by the water which rises in the gas-holder, the latter being meanwhile covered with black cloth to prevent the action of light upon the nitrogen.

Nitrogen thus purified and rendered active by the passage of an electric discharge will combine with vaporised zinc, cadmium, mercury, sulphur, and other elements to form nitrides, which are decomposed by water, with the liberation of ammonia. It reäcts with carbon bisulphide to produce a blue polymerised carbon monosulphide and a blue nitrogen sulphide, while it decomposes sulphur chloride with the formation of the ordinary yellow nitrogen sulphide. It appears to act upon most organic compounds, liberating hydrocyanic acid, but carbon tetrachloride is not decomposed in this way.

ACTION OF OZONE ON FIBRES.—The results of experiments to determine the effect of ozone upon different textile fibres are described by Mr. C. Dorée in the *Journ. Soc. Dyers and Col.*, 1913, XXIX, 205. In each case the yarns were exposed to the action of oxygen containing 1·5 to 2 per cent. of ozone and their relative breaking strength and elongation determined after various periods. In the case of cotton and artificial silk there was but little reduction in the strength during the first hour, but subsequently the deterioration was very rapid, and after twelve hours the breaking strength had fallen from 30 to 50 per cent. This alteration in the physical properties was accompanied by a chemical change. For example, a sample of cotton-wool, containing 44·4 per cent. of carbon, showed only 43·5 per cent. after the oxidation. Flax was attacked much more rapidly than cotton, and yielded formic acid and solid acids, but dry wool was hardly affected after several hours' exposure to ozone in the presence of moisture. If the wool were first soaked in water, however, a rapid decrease in its strength and elongation was observed, while silk under similar conditions was rapidly attacked by ozone.

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GEOGRAPHY.

By A. STEVENS, M.A., B.Sc.

TENTH INTERNATIONAL GEOGRAPHICAL CONFERENCE.—This conference was held at Rome in the end of March and the beginning of April. Unfortunately it had been twice postponed, and the consequent was that the attendance was only half that at the foregoing conference. It was decided that all papers notified for the postponed meetings should be read, but the authors of many of these were not present. Several of the sections held very few meetings: in one case only a single meeting was possible, and the sessions were often unexpectedly short. Possibly the most interesting discussions concerned the international map of the world on the scale of 1:1,000,000. With it, as well as with other maps on larger scales for international use, considerable progress has been made. The important question of uniformity in the spelling of names on maps, particularly on those of uncivilised and polar regions, was also raised, and we may hope that shortly satisfactory and uniform methods of spelling will be adopted.

EXPLORATION.—The Canadian Arctic Expedition left British Columbia in June to explore certain circumpolar regions, notably the area of the Parry Archipelago. Reasons based on a detailed study of tidal currents have been brought forward by Dr. R. A. Harris for supposing the existence of an Arctic continent, stretching from the 75th beyond the 85th parallel, N. latitude, and lying between one hundred and one hundred and fifty degrees W. longitude. Peary believes he saw the outposts of such a land north-west from Cape Thomas Hubbard, and Greely also supports Harris' opinion. Nansen, however, thinks the area is occupied by a deep polar basin. The expedition has been equipped and staffed for comprehensive scientific work. The operations will be based on Melville Island, and will be directed to exploration of the Archipelago and to investigation of the region to the north-west, where the supposed continent should lie. They will occupy three years.

An elaborately equipped expedition to Eastern Turkestan, under Italian auspices, and led by Dr. D. Filippi, is completely organised, and will set out shortly. The leaders will join the main party in Asia next March.

EARLY MAN IN SOUTH AMERICA.—Bulletin 52 of the Bureau of Ethnology of the Smithsonian Institution contains the results of the work of a party which investigated the human remains of Argentina. The purely geological work shows that the Pampas have been built up by wind and rivers acting alternately, as the delta plains of Eastern China are at present being formed. Huge deposits of loess are found.

Abundant evidence of the existence of man in Argentina at an early date was discovered. But the men of the Pampas were of a well-marked American Indian type, and there is nothing to indicate very great antiquity or that man has been primarily or independently evolved in South America. As is pointed out, the report contains no positive evidence against the theory of the evolution of man in that region; nevertheless, there is abundant evidence against it of the negative kind.

PROBABLE EFFECTS OF THE PANAMA CANAL.—To the March issue of the *Journal of the Royal Statistical Society* Professor L. Hutchinson contributes a suggestive paper on this subject, which Professor T. Russell Smith also discusses in the March *Journal of Geography*.

The eastern seaboard of the United States and the European centres of trade on the one hand, and on the other the markets of Pacific countries, are chiefly affected. Professor Hutchinson points out that in the market countries there is already considerable development evident; they are well on the way to supplying many of their own requirements in food and clothing, and the main increase in imports is to be expected in manufactured goods, notably of steel. Their export trade is likely to develop most in vegetable products, in meat and animal fibre, and in minerals. A statistical study of the facts confirms the general idea that of manufacturing countries Britain, Germany, and the United States will be mainly affected; and of these the foreign trade of the last shows the widest growth, while that of the first is on a downward gradient. Though the changes will not be so fundamental as those consequent upon the opening of the Suez Canal, Professor Hutchinson believes that whatever modifications political causes may impose, the commercial factors will produce an important acceleration of the advance of the trade of the United States. Professor Smith holds that the Canal will bring about "the greatest readjustment of all time" and affect profoundly the volume of trade carried by every important ocean route as well as the routes themselves.

VARIATION OF THE WATER-LEVEL OF LAKE TANGANYIKA.—An attempt has been made to assign a period and amplitude to this variation in a paper in the *Mitteilungen d. Deutschen Schutzgebieten*, 1913, No. 1. The upper limit is got from terraces marking old shores seven to ten metres above the present surface level towards the north end of the lake; and it is believed that the water reached the topmost shortly after the time of Stanley's visit (about 1878). At this time the outlet by the Lukuga to the Congo drainage system was silted up; but the bar was pierced about 1880, and there seems to be no reliable information as to whether it has been re-formed since. At Usumbura a post placed at the water edge some thirteen years ago now stands twenty metres out from the shore in ·78 metre of water, and it has been concluded that the minimum level is about one metre below the present surface, reached last about 1908. Thus the period is put at thirty years, and the amplitude at eleven metres. The fall in level, however, has been frequently checked and reversed, sometimes for a space of years, and there is no good reason to believe that a major rise has now set in. If definiteness is to be assigned to the phenomenon much more exact and continuous information must be collected over a greatly extended time.

GEOLOGY.

By G. W. TYRRELL, A.R.C.Sc., F.G.S.

THE MICROSCOPIC EXAMINATION OF COAL.—Thin sections of coal are extremely difficult to make owing to the brittleness and softness of the material, and when made the opacity and homogeneity of the material frequently render the microscopic examination very disappointing. By the use of a tough cement, however, J. Lomax (*Transactions of the Institution of Mining Engineers*, Vol. XLII, Part I) has been enabled to make very thin sections of coal, and finds definite structures, each seam having its own special characteristics. In thin section most coals are found to be laminated with alternating bands of bright and dull material. Even the brightest coals when sliced show this lamination. The dull bands are chiefly composed of numerous megaspores embedded in a ground-mass of microspores; whilst the brighter portions are built of the smaller microspores with highly compressed remains of leaves and other vegetable tissues. Other coals show compressed woody tissues, sometimes in the form of "mother of coal," or having a resinous appearance with the tissue preserved. Other structures are frequently seen: some are oval and intensely resinous in appearance. These have been named *Ovalites resinosus* by Mr. Lomax. In some of the coals beautiful amber-coloured bodies of various shapes and sizes are found, to which the author proposes to give the provisional name of *Amberites*. Many species of megaspores are found in the various coals, one species being confined chiefly to each seam.

The author gives the results of the examination of many Lancashire coals, and has illustrated their microscopic appearance in many fine plates. The cannel coals are found to consist of an agglomeration of microspores, with here and

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there a few megaspores. Some of them grade into a material which is nothing but a black carbonaceous mudstone. The majority of the coals examined are humic coals, composed of the droppings of trees and plants in the form of spores, fruits, leaves, twigs, and sometimes fragments of flattened stems. Mr. Lomax comes to the conclusion, contrary to some recent opinions, that no great quantity of wood enters into the composition of coal; and what there is occurs mostly in the form of charcoal or "mother of coal." In the hardest, purest, and brightest coals the material has been reduced to a more or less pulpy state before carbonisation.

An interesting and important practical application of these results has been made. The author suggests that the microscopic examination of a coal-seam may be a good guide as to the inflammability of the dust likely to be given off. Many coals have been shown to be composed largely of the spores of the huge Lycopods of the Carboniferous period, plants whose descendants are the recent Selaginellas and Club-mosses, the spores of which are known to be highly inflammable. The spores in the coal have not lost their highly inflammable and explosive nature during their long entombment, and when released in the form of dust during working produce a highly explosive mixture. Many coals, moreover, contain the resinous and inflammable bodies known as *Ovalites resinosus*. Hence coals rich in megaspores and *Ovalites resinosus* are likely to give rise to a very explosive dust, and this conclusion is borne out by the microscopic examination of coals which are known to produce such a dust.

ALLUVIAL FAN FORMATIONS.—In arid regions of high relief, such as the western deserts of North America, there are huge deposits of rock-detritus in the form of confluent or interdigitating alluvial fans. These fans or cones are deposited by occasional violent torrents, and, owing to the diminishing velocity and carrying power of the water towards the lower levels, a more or less regular gradation occurs from large blocks at the upstream point of the fan to fine silt in the playas, or river-bottoms. This material is prevailingly angular, although there may be admixture of rounded pebbles due to the denudation of old conglomerates in the mountains from whence the detritus is derived. When cemented these fan-deposits are called "breccias," in accordance with current usage; but as A. C. Lawson points out (*Bulletin of the Department of Geology, University of California Publications*, Vol. VII.), the term "breccia" is so overloaded with meanings that it has no particular connotation suggestive of the kind of rock to which it is applied, or its origin. Hence Dr. Lawson proposes the new term "fanglomerate"—a particularly ugly hybrid—for the deposits described above. He also points out the scarcity of rocks of this kind in the older geological formations, even after making due allowance for possible non-recognition or disguise under other names, and suggests that this may be explained by the supposition that the combination of bold relief and aridity was not common in the geological past. It is further concluded that the period of time from the Quaternary to the present is exceptional in geological history in respect to the coëxistence of these two conditions over a large portion of the North American continent.

METEOROLOGY.

By WILLIAM MARRIOTT, F.R.MET.SOC.

THE "FERNLEY" SELF-RECORDING RAIN GAUGE.—The Southport Meteorological Observatory is considered by meteorologists to be one of the best equipped observatories in this country. When the Royal Meteorological Society held its Provincial Meeting at Southport in May last year, the Fellows had an opportunity of inspecting the Fernley Observatory and the Marshside Anemograph Station, and also of seeing the large collection of instruments at work, the great care bestowed upon them, and the remarkably clear and valuable records obtained from them. Mr. Joseph Baxendell, the Borough Meteorologist, in his Report for 1912, describes the "Fernley" self-recording rain-gauge, which he has just brought out and added to the equipment of the Observatory. In this he has introduced a new action of siphoning, and also added other improvements. Figure 376 illustrates the working of the instrument.

The rain collected by an 11-inch deep-rimmed funnel [not shown for want of space] passes through a wide pipe (C) to the cylinder (A), raising the float (B) and a new anti-friction wheels' pen-carrier, until 0·50 inch has fallen, when a cam (K) throws over a rocking-weight shown, and this, by means of a tripping-rod (J), causes the contents of a tilting-bucket

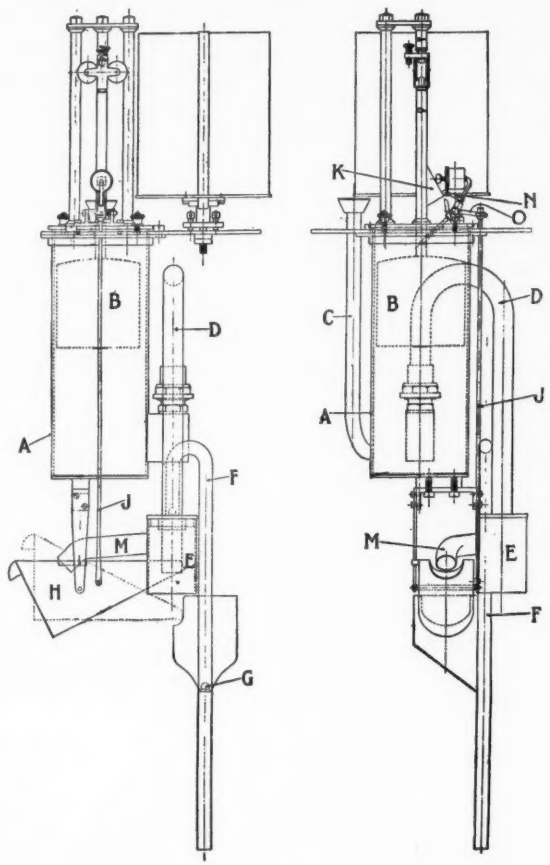

FIGURE 376.

Plan of the "Fernley" Self-Recording Rain Gauge.

(H) to be emptied into a water-air-pump (G, F). A §-inch bore copper syphon (D) above the pump, and leading from the side of the rain cylinder (A) to a trap (E), is rapidly exhausted by the water-air-pump and, coming into action full-bore, empties the half inch of rainfall in half a dozen seconds, the pen returning to zero on the chart. The water, escaping through a pipe (M), refills the tilting-bucket (H), which is raised or "righted" not merely by the flush of water, but also by a lever (O) that is actuated by the rocking-weight while the latter is being raised into position (through a pin and lever) by the weight of the descending float (B). A detent (N) locks the rocking-weight until rainfall has caused the pen once more to approach the top of the chart; the rocking-weight cannot, therefore, be accidently thrown over in the meantime.

This new rain-gauge, which is made by Messrs. Negretti and Zambra, works in a most satisfactory manner, and will be of great value not only to meteorologists, but also to engineers, surveyors, and all others who require continuous rainfall records of a thoroughly reliable character.

THE U.S. TORNADOES OF MARCH 23RD, 1913.—In connection with the system of low barometric pressure which crossed the United States during the latter part of March, severe local storms occurred in portions of Kansas, Nebraska, Iowa, Illinois and Indiana. The tornado at Omaha, Nebraska, on Easter Sunday, the 23rd, was most destructive. From the account in the *Monthly Weather Review* it seems that ninety-four persons were killed, as well as thirty-three horses, four cows and five mules. At Terre Haute, Indiana, the tornado was less than two minutes in traversing the city, during which time about three hundred and thirty houses were demolished or badly damaged, two hundred and fifty persons injured and twenty-one lives lost. The Weather Bureau official states: "I have talked with several persons who were caught in the tornado. They saw the funnel-shaped cloud touching the ground in places and house after house crumbled as it passed over them. They say the roar was deafening, and I was told by several persons that it could be heard for a mile. Many freakish things resulted: chickens were defeathered, the clothing was drawn off a bed through a fireplace and thence up the chimney; in one house the linoleum was raised off the floor; in another a baby was lifted out of its bed, carried a square, and laid down without injury; toothpicks were driven into the hard wood of a sideboard on which they were laid, and a splinter of wood was driven through a large phonograph horn."

ELECTRICAL STORM IN KANSAS, MARCH 23RD.—During the greatly disturbed weather conditions referred to in the preceding note, an unusually severe electrical storm occurred in the three western tiers of Kansas counties on Easter Sunday, March 23rd. From an account given by Mr. S. D. Flora we learn that during this storm windmills, especially steel mills mounted on wooden supports, became so charged with static electricity than anybody touching them received a distinct shock, and in some cases the shock was a severe one. The observer at Tribune, Greely County, reported an instance where sparks two or three inches long were drawn from a wire running to a windmill. Telephone and telegraph wires and wire fences also became charged sufficiently to give quite noticeable shocks, and in Scott County, where the disturbance seems to have been most severe, one case was reported where a prairie fire was thought to have originated from electric sparks caused by a break in a wire fence. The observer at Scott City also reported that sparks passed from a person's finger held near a horse's ear, and that the horse would shake his head as though he felt the contact of the spark. These electrical phenomena, which occurred during high south-west to west winds, were generally experienced from early morning until about sunset; and during this time the air was filled with dust and was very dry, with no precipitation during the storm, though light rain fell in the north-western part of the State early in the evening.

THE VELO CLOUD.—Dr. Ford A. Carpenter in his recently published book, "The Climate and Weather of San Diego and California," gives the following account of the Velo cloud which is such a characteristic feature in the climate of St. Diego. "While the velo cloud is common to the Pacific Coast generally, and has been observed as far north as the Straits of Fuca, this cloud reaches its perfection over the littoral region of Southern California. The velo cloud is the chief characteristic of the summer climate of the San Diego Bay region. And summer should be understood as covering all the year excepting November, December, January and February. These four months could easily be reckoned as spring-time. The screening of this region from the sun's rays is so thoroughly accomplished that, during a normal summer's day, the sun breaks through the velo cloud about 10 o'clock, the sky clearing shortly afterwards and remaining free from clouds until about sunset. That the velo cloud is effective as a sun-shield, it needs only to be stated that the average of all the July maximum temperatures since weather observations began shows a mean of about 78°.

"The cause of the formation of the velo cloud and, consequently, the cool summers of St. Diego, is, strange to say, found in the hot weather in the interior of California and Arizona. It is a unique example of the aptness of the proverb, 'It's an ill wind that blows nobody good.' The hot weather in the interior produces an aërial eddy (the 'low' of the weather map), and the difference in atmospheric pressure between the interior and the ocean results in giving San Diego cool, uniform days and nights, free from extremes, or what is really the summer temperature of the Pacific Ocean. The velo cloud should therefore be incorporated in our local vocabulary, and it should replace the misnomer 'high fog.'"

VERIFICATION OF METEOROLOGICAL INSTRUMENTS.—Dr. C. Chree, in his Report of the Observatory Department of the National Physical Laboratory, has given a list of the instruments examined at the Kew Observatory during the year 1912. The testing of barometers and hydrometers was transferred to Teddington in November, but including these it is shown that the total number of instruments—exclusive of watches and chronometers—examined during the year was 40,324, an increase of 3,875 on the previous year. The number of barometers and thermometers tested was:—

Barometers—Aneroid	...	...	261
„ Mercury	...	...	351
Thermometers—Clinical	...	...	20,909
„ Deep Sea		...	55
„ Meteorological	...		9,133
„ Standard	...	...	107
„ Other forms		...	1,216

It is stated that the increase in the number of thermometers tested is due in considerable measure to the introduction of new regulations by the Home Office for cotton factories. These factories are required by law to have dry and wet bulb thermometers to show the hygrometric conditions prevailing, and the new regulations required the introduction of what was practically a new type of thermometer. Thermometers of "other forms" are also much more numerous than usual, owing partly to a specially large supply of those of the type issued in connection with the chilled meat trade.

MICROSCOPY.

By F.R.M.S.

A NEW PHOTO-MICROGRAPHIC APPARATUS.—Although one hesitates to apply the word "new" to any form of mechanical contrivance nowadays, seeing that any newness about such things partakes of the nature of a fresh arrangement of old principles or ideas, yet I venture to say that the subject of this note presents various conveniences which the photo-micrographer has not been able to enjoy hitherto. I have had this piece of apparatus in practical use for some time, and strongly commend it on account of its convenience, ease of working, and also its efficiency. Figure 377 shows a general view of the apparatus. It is here seen resting on a long narrow table which was especially designed and made for this purpose. The table bed, which is of solid oak rather more than an inch thick, is supported by one pillar at each end. The pillars divide so that the table rests on four feet with castors of the form used for billiard tables. Under the table-bed are three hanging drawers "running through" and so get-at-able equally well from either side of the table. The apparatus can be dismembered and all parts, except the long square base bar, stowed away in these three drawers. The legs of the table are fixed to the table top by nuts and bolts, so that it can be taken to pieces for travelling.

The shoes, and so on, are all tapped with the same thread, so that the various parts are interchangeable in position.

The photographic part consists of a five and a half feet long straight, solid, square steel bar or base, A.A. On this slide a number of square-fitting shoes supporting the various parts. These shoes slide quite freely, and may instantly be clamped in any position along the bar by means of milled headed screws at the lower angle. The lamp end of the bar has a one-legged

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shoe, B, while the camera end rests on a two-legged shoe, C. All three of these legs are adjustable by means of screws, so that the apparatus can be levelled on a non-level table. [This special table is not an essential part of the outfit. A friend has a similar piece of apparatus which is supported on a shelf firmly bracketed to the wall, and finds this entirely satisfactory.]

Now briefly to enumerate the parts. AA, the square base bar, arranged with its diagonals vertical and horizontal; B, the one-legged support, here shown resting on a thick pad of pieces of cloth (the best absorber of vibrations that I know of); D, the first sliding shoe, into which screws a round vertical metal rod or lamp support; E, the gas tap for light, which by a screw can be fixed at any desired height; E is connected to the gas supply by a piece of rubber tubing; F is the holder of an inverted gas mantle. I find the "Howelite" excellent, the light is intensely brilliant and steady, and the mantles stand a surprising lot of rough usage. When not in use I lift off the part F carrying the mantle and slip it on to a piece of round wooden rod fixed into a loose triangular foot, and keep it in one of the drawers. The next four sliding shoes have vertical brass cylindrical pillars screwed into them. Inside each pillar another tube slides. This latter can be fixed at any height by a clutch screw collar, the upper part of the outer tube being cut in two places so as to permit of the taper thread forming a throttle grip. The first of these pillars G, *i.e.*, the one next the lamp, carries a "paralleliser" or condensing lens of the crossed lens type which can be centred by three screws and springs. H, the next pillar now unoccupied, can hold a water tank if required. The one, J, here carries a contrivance for holding a two-inch square colour screen in three sides of a square rebate or groove. On the other side of the circular head are two spring clips like those on the stage of a microscope. These we may use for other colour screens, and so on. J can also be used as a stage object holder for such things as shells, fossils, suitably mounted, and so on, when photographing with a short focus objective without the microscope. K, is another shoe and pillar not occupied at the moment. L, the microscope with M, a sliding baffle tube embracing (without touching) a projecting short tube in front of the camera, thus providing a light-tight joint between microscope and camera, but without contact between these two pieces. P, the bellows of the camera, is prevented from sagging by a shoe and sliding pillar arrangement Q. At C, we have the two-footed support (cloth has been removed to show details). R, is a reflector or mirror on a separate tripod foot and sliding pillar with knuckle joint at the back, fixed at any angle at will by a screw. Thus one can stand at any place along the table edge and yet see the reflected image of the focusing screen in this reflector R. On the further side of the base bar is a long steel rod. At one end is S, a large milled head used for working the fine adjustment of the microscope. At the other end, here out of sight, but shown in Figure 383, is a grooved circular disc U. This carries a silk cord which passes round the head, T, of the fine adjustment. Details shewn in Figures 378–382—V, is a pulley-weight which keeps the silk cord taut and of even tension. Going round the camera end of the table we get the view shown in Figure 383, where S is the head of the fine adjustment focusing rod. C is the two-legged support here shown resting on pads of cloth. At R we see the back of the mirror holder with screw knuckle joint, sliding pillar, and tripod foot. At U is placed a pointed bit of white card to indicate the grooved disc on the focusing rod which carries the silk cord focusing tackle. In this view we see how the camera is supported on two U-shaped or forked uprights (detachable), so that the camera can be adjusted at any height by the screws, *b*, *b*. By removing the butterfly screws, *a*, *a*, the two supporting forks lift off their respective sliding shoes. The sagging of the bellows results from removing the supporting pillar, Q, seen in the first view.

Figure 380 shows us a little more detail as to how the microscope is supported on the metal table, *d*, *d*, which is fixed to its own pair of sliding shoes by the butterfly nuts, *d*, *d*. The three feet of the microscope fit into three ring collars, *e*, *e*, *e*, on the base plate. At *f* is shown a contrivance like a shallow pill box lid of white card. This fits the distal end of the sub-stage condenser at *g*. On this are drawn two or three concentric circles in black lines by compasses. When this light-adjusting cap is *in situ* at *g* it greatly helps in adjusting the positions of the lamp, E, F, and lens, G, so as to get an even image of the mantle mesh truly centred. If now we open the camera back and look through the microscope tube we can see at a glance (*f* being removed, of course), if our light, F, and lens, G, are on the axis of the tube. At *h* we see a new form of speculum condenser consisting of a stout clear glass rod polished at one end and ground at the other end. Before leaving this figure we may glance at the silk cord and then see it in detail in Figures 378 and 382; this being, so far as I know, an entirely new design. The letters T, U and V as before refer to the milled head of the fine adjustment screw, the grooved wheel on the focusing rod, and the weight with pulley head. The pulley head is notched, so that it can be easily detached. The cord is also easily lifted off T and U, so that it remains only attached to the table *d*, *d*. It may be noted that the edge of the table under the pulley wheels of the table is cut away on both sides to facilitate the unshipping of the focusing tackle. The silk cord is so arranged that at no part of its course does the cord rub against itself, and there is quite even tension at T. *i.e.*, no side-pull at all.

Figures 379 and 381, show us the arrangement for the light-tight connection between the microscope and camera. At M we have a double tube, which, by means of a collar, slides freely on the inner draw tube K which may or may not carry an eye-piece as we may desire. Between these (inner and outer) tubes goes a similar flange-mounted tube, N, on the front of the camera as shown in Figure 381. The camera has a loose panel front fixed by four turn buttons, so that short-focus photographic objectives may be used without the microscope in conjunction with certain other contrivances which may be held over for a further note.

This apparatus has been especially made for me under the supervision of Mr. W. R. Biss (106, Elmore Street, Canonbury, London N.,) who is an enthusiastic amateur in microscope and camera matters, and to whom is due the credit of designing many of the contrivances above mentioned.

F. C. LAMBERT, M.A., F.R.P.S.

CORRECTION.—By an accident the blocks of two figures on page 272 [Volume XXXVI (1913)] have been interchanged. The description of Figure 285 should, therefore, read "*Pisidium obtusale*" which is the most globular species, and Figure 293 should be *P. millium*, the squarest.

PHOTOGRAPHY.

By EDGAR SENIOR.

PLATINUM TONING.—Although the toning of silver prints by means of a salt of platinum has not been practised to anything like the extent that gold toning has, the method is nevertheless a useful one, and at the same time capable of giving excellent results either when used alone or following after a preliminary toning with gold. The use of platinum salts in toning certainly dates back at least forty years, but it cannot be considered as having been successful until the introduction of the chloroplatinite of potassium by Mr. Willis for platinotype printing, as attempts to use the ordinary tetrachloride of platinum more often than not resulted in failure. One of the earliest, perhaps, to devise a really simple and satisfactory process of platinum toning was the late Mr. Valentine Blanchard, who supplied a matt surface printing paper together with the toning solutions for the prints made upon it. Since then, however, numerous formulae have from time to time been published for the toning of silver prints with platinum that leave little to be desired. Collodio-chloride papers especially give good results when toned in this way. When the treatment with the platinum solution follows toning with gold the following method may be recommended:—

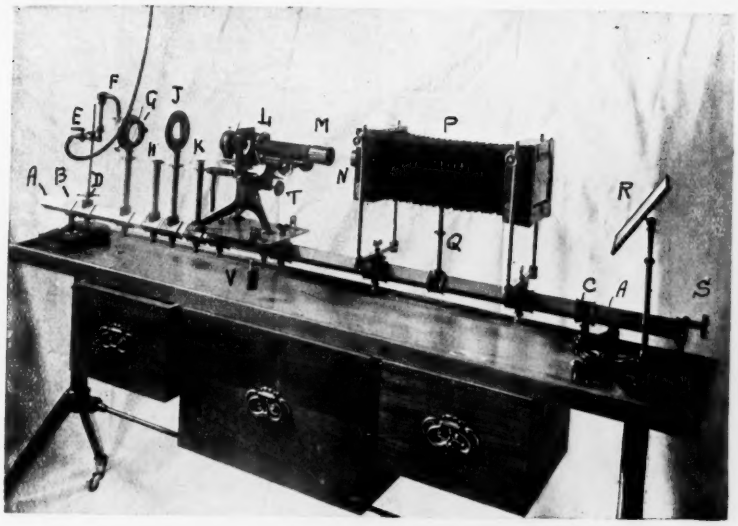

FIGURE 377.

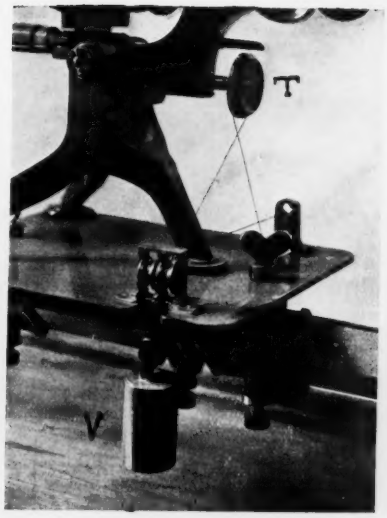

FIGURE 378.

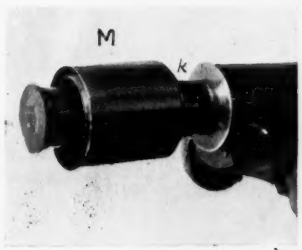

FIGURE 379.

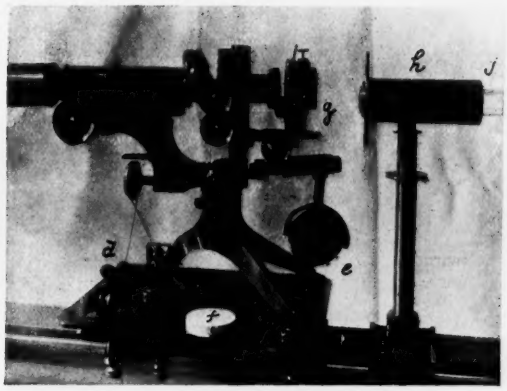

FIGURE 380.

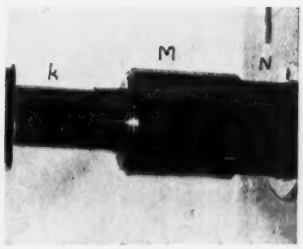

FIGURE 381.

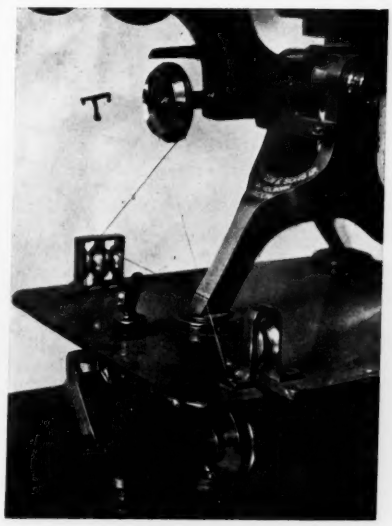

FIGURE 382.

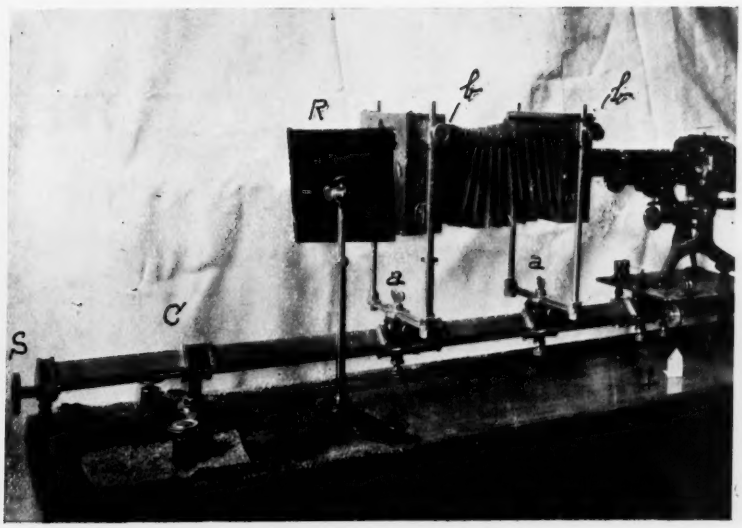

FIGURE 383.

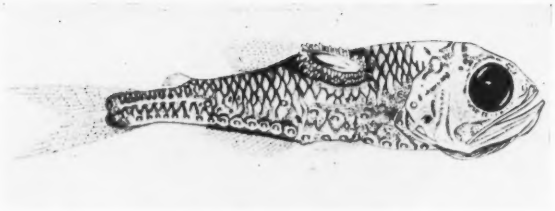

Figure 384.

The Fish (*Scopelus glacialis*) with the combined parasites, *i.e.*, the Parasitic Copepod carrying the Hydroid.

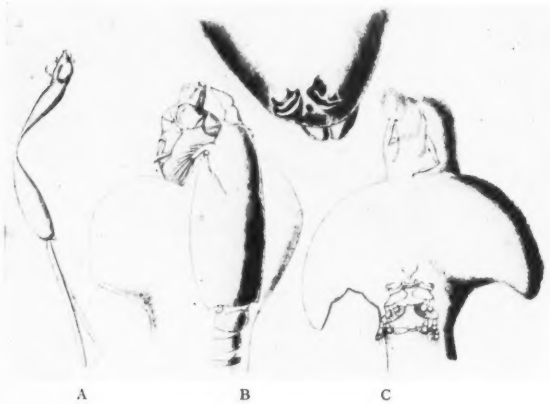

FIGURE 385.

(A) The Parasitic Copepod (*Sarcotretis scopeli*) adult female with egg strings; (B) Front part of the same, dorso-lateral view; (C) Ventral aspect.

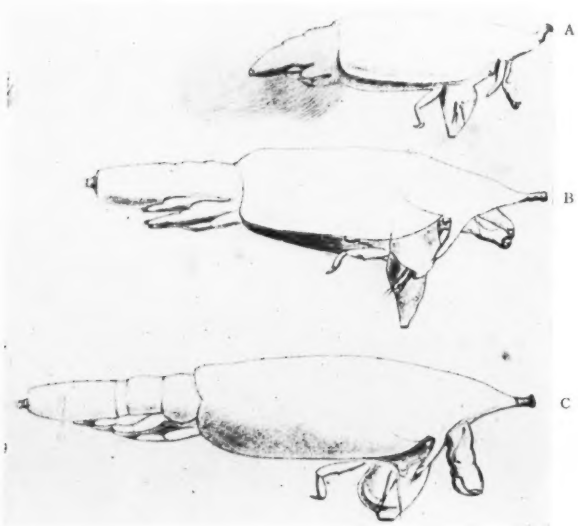

FIGURE 386.

Pupal stages of *Sarcotretis*, lateral views (A) 2nd; (B) 3rd, Male specimen; (C) 4th.

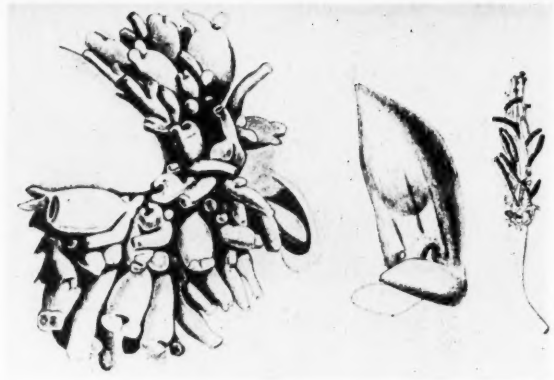

FIGURE 387.

(A) The basal part of the Copepod with Polypes and Medusae-buds; (B) Large Medusae-bud; (C) Young Hydroid colony (*Ichthyocodium sarcotretis*) without Medusae-buds.

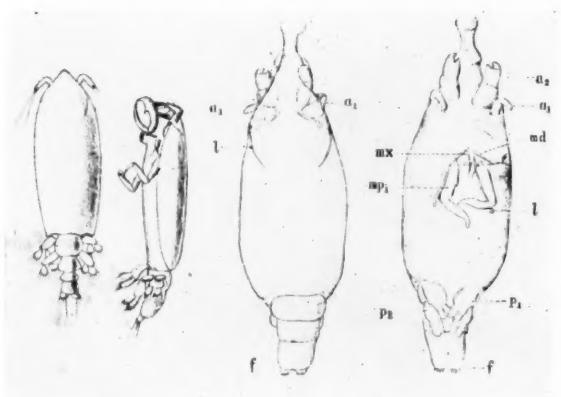

FIGURE 388.

(A) Cyclops stage of *Sarcotretis*, dorsal and lateral view; (B) 1st, Pupal stage, dorsal and ventral view.

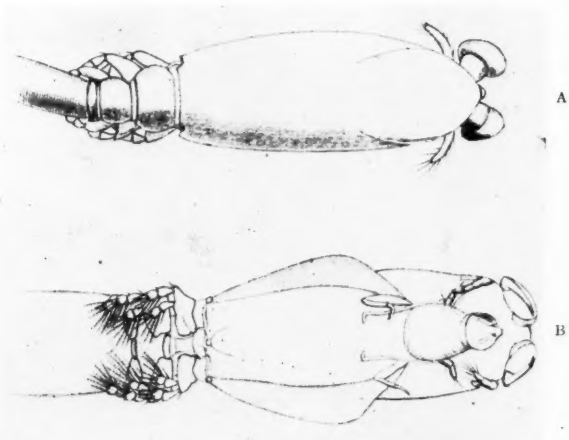

FIGURE 389.

(A) Front part of young female in the boring stage, dorsal view. (B) The same somewhat more developed, ventral aspect.

A Hydroid Epizoic on a Parasitic Copepod (*see page 354*).

Wash the prints in several changes of water and then tone in the following bath—

Borax	... 35 grains.
Sodium Acetate ...	... 35 grains.
Water (Distilled) ...	... 7 ounces.
Gold Chloride	... 1 grain.

This solution should be made up as required, as it will not keep. The prints are toned in this to a chocolate brown. They are then rinsed and placed in the following bath—

Potassium Chloroplatinite	... 5 grains.
Water	... 10 ounces.
Phosphorous Acid, 1·12	... 75 grains.

This solution may be used over and over again until exhausted. If the preliminary toning with gold is not carried too far the final treatment in the platinum bath should yield a good black. The prints after toning are well washed and then fixed in a solution of hypo of the following strength—

Hypo	... 3 ounces.
Water	... 20 ounces.

This should be freshly prepared and about twenty grains of soda carbonate added to it when fixing platinum-toned prints, or, if preferred, the prints after toning may be rinsed, and then placed in a five per cent. solution of soda carbonate until ready for fixing. After remaining in the fixing bath for about fifteen minutes the prints should be washed in running water for two hours. When it is desired to tone with platinum only without the use of the preliminary gold bath, the following formula for the solution may be employed—

Potassium Chloroplatinite	... ½ grain.
Water	... 30 ounces.
Hydrochloric Acid ...	... ½ drachm.

or in place of the above we may use one containing chrome alum, thus—

Chrome Alum	... 120 grains.
Potassium Chloroplatinite	... 1 grain.
Water	... 10 ounces.

When the prints are toned they are placed, after a slight washing, in a five per cent. solution of soda carbonate and allowed to remain there until all are ready for fixing.

SULFINOL DEVELOPER.—A further addition to the already large number of bodies which act as developing agents has recently been made by the preparation of a substance—by M. J. Desalme—termed "Sulfinol." Those who wish to experiment with this new compound will now be able to do so, as it is being manufactured by the Société des Matières Colorante et Produits Chimiques de Saint Denis, 105, Lafayette, Paris.

Sulfinol is a bluish-grey powder only slightly soluble in water, but much more soluble in water containing soda carbonate and other alkalies. It appears to contain the sulphonic group—SO_3H, and somewhat resembles Glycin in its slowness of action. It gives soft negatives having excellent gradation and good detail in the high lights. The colour of the deposit verges on brown. The addition of bromide has the effect of greatly slowing the developing action. Sulfinol appears to be specially useful in the development of bromide prints and enlargements on account of the warm tones obtainable by its means. The developing action, however, is very slow, the image taking about three minutes to appear and requiring from seven to eight minutes for complete development; but the length of time required does not appear to cause any fogging action to take place over the lights. We append the following formula recently published by Captain R. Hergeth in "Wiener's Mitterlungen" for the preparation of a sulfinol developer for bromide paper—

Sulfinol	... 10 to 15 grams.
Soda Sulphite (Crystals)	... 40 to 50 grams.
Soda Carbonate (Anhydrous)	30 grams.
Water	... 1,000 c.c.

The soda sulphite and carbonate are first dissolved in about 200 c.c. of water and then the sulfinol added, the solution being finally made up to 1,000 c.c. with the addition of water. This developer keeps well and is always ready for use. Sulfinol may also be employed in conjunction with hydroquinone when a developer is obtained which acts much more rapidly and can be used for both plates and papers. Prints made upon bromide paper may be developed with the mixed solutions in about two minutes,—without bromide—and the image will have a pleasant warm brown colour. Some six or eight prints may be developed in the same solution, although after the first two or three it becomes much slower in its action. Finally, the sulfinol-hydroquinone developer may be said to supply the means for obtaining prints of a warm tone by direct development, and in this way is a useful alternative to that of after-toning.

ZOÖLOGY.

By PROFESSOR J. ARTHUR THOMSON, M.A., LL.D.

ACCESSORY CARTILAGE IN BAT'S WING.—Oskar Törne recalls attention to an interesting extra cartilage which lies to the outer side of the last joint of the little finger in all Vespertilionidae. It is not bound to any other part of the skeleton, and has considerable independent mobility. Fibrous strands of connective tissue extend from the accessory cartilage into the posterior margin of the wing, and probably move it in some independent way during flight. What the accessory cartilage really is remains obscure, and must remain so until its development in the embryo is worked out.

EXTRAORDINARY MODE OF PARENTAL CARE IN A FISH.—In one of the rivers of New Guinea the explorer Lorentz found a remarkable fish, *Kurtus gulliveri*, whose parental care has been described by Professor Max Weber. In the mature male a bony process on the back of the skull grows forwards and downwards, and forms a ring or "eye." In this, somehow or other, a wreath of eggs is attached. Each egg bears radiating filaments—over a hundred in number—which unite into strings, and these form a cylindrical band. This band passes through the bony ring, and the male carries the eggs on the top of his head. The details of the curious attaching filaments which fasten the eggs together have recently been studied by Professor F. Guitel, who compares the filaments with those of another fish, *Clinus argentatus*. The adaptation is very remarkable, and one would like to know more in regard to the manner in which the eggs come to be fastened to the bony ring.

THE HERMIT CRAB AND ITS BORROWED SHELL.—In his recently published memoir on the Hermit Crab—an admirable piece of work—Mr. H. Gordon Jackson discusses the old question whether the crustacean forcibly ejects the mollusc. Bell argued from the frequent freshness of the shells that the hermit must eat the mollusc out of its home, and fishermen sometimes catch the soldier hermit crab (*Eupagurus bernhardus*) devouring a whelk. But Mr. Gordon Jackson points out that while the argument and the observation are both sound they do not prove that the hermit crab attacks the living Gastropod. "In the first place it is not very conceivable that a hermit crab would have the strength to remove bodily, or the appetite to devour, an extremely tough animal like the whelk." In the second place it is well known that "the cod feeds very largely on the whelk, and that nothing but the operculum is ever found in the fish's stomach. The mollusc's fleshy portion (chiefly the foot and head) must therefore be bitten off while expanded—a comparatively simple matter to the active and powerful Teleost—leaving the softer (visceral) parts inside the shell." The hermit crab may then clean up the remains and ensconce itself in the emptied shell.

CHEMISTRY OF THE SILKWORM.—R. Inouye finds that the chemical composition of the silkworm is greatly

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changed in the metamorphosis, but there is not much difference between pupa and moth. There is no loss of nitrogen in gaseous form during the metamorphosis. During the pupal and moth stages the greater part of the fat accumulated by the silkworm is consumed. In the pupal and moth stages the waste of body protein is repaired with amino-acids, and a part of the latter is further transformed into ammonia. Splitting of the protein in the silkworm is caused by the action of some proteolytic enzyme.

GEOGRAPHICAL DISTRIBUTION OF BED-BUGS.—The family of bugs known as Cimicidae is nowadays represented all over the world—seven species in Europe, six in Africa, five in Asia, two in Australia, and seven in America. The two Australian species are importations by man, and the same two have been introduced into America. Dr. G. Horvath, of Budapest, has been recently looking into the matter, and finds reason to believe that the common bed-bug (*Cimex lectularius*) is indigenous in the Mediterranean region, whence it has spread everywhere. The other bed-bug in the strict sense is *Cimex hemipterus*, a native of tropical regions of Africa and Asia, whence it also has been transported to various parts of the world, such as the Antilles and Brazil. Dr. Horvath thinks that both species of bed-bugs were, like most of their fellow-species, parasites of bats to begin with, and that they shifted their attention from bats to man.

A MARINE BUG.—In 1878 Baron Bonnaire discovered a marine Hemipteron, *Aëpophilus bonnairei*, which lives under deeply imbedded stones at low tide. It can live for days under water—indeed, it often occurs at levels which are not uncovered except at very low tides. It also occurs higher up in the Fucus zone. More information in regard to its distribution has been recently collected by R. Lienhardt, who points out that the insect probably gets into crevices with imprisoned air. More than one naturalist has found it on the back of a starfish and among worm-tubes and the like. There are records of its occurrence from Cornwall, the Channel Islands, Wimereux, Tatihou, Roscoff, Concarneau, Ile de Ré (where it was first found), and from Galicia.

FORAMINIFERA AS WORLD-BUILDERS.—From Cambrian times or even earlier the shells of Foraminifera have contributed notably to the crust of the earth. Messrs. Heron-Allen and Earland have contrasted the contributions made in different geological ages. Thus there is but a single record of Foraminifera for the Devonian, while in the Carboniferous they began to form enormous deposits. There were many forms in the Cretaceous, but they did not form the great deposits characteristic of the Foraminiferal Golden Age in the beginning of the Tertiary times. Nowadays, as everyone knows, a few pelagic genera are building up great deposits of Globigerina ooze on the floor of the deep sea. In regard to the beds of chalk ranging from the Chalk Marl to the Upper Chalk, the authors make a useful note: "It is one of those popular beliefs which die so hard that chalk is made up entirely of the shells of the Foraminifera, and the textbooks and microscopical works abound with statements to that effect. . . . The so-called 'spheres' of the chalk are perhaps the origin of the belief that chalk is built up of the shells of Foraminifera. But, whatever the 'spheres' may be, we are convinced that they are not Foraminifera." They may be the firm tests of Infusorians. There are, indeed, plenty of Foraminifera in many zones of the Chalk, but in most cases their number is small compared with the whole bulk of amorphous matter.

A HYDROID EPIZOIC ON A PARASITIC COPEPOD

AT the Portsmouth Meeting of the British Association, held in 1911, Professor Hector Jungersen, of Copenhagen University, read a paper on a new Gymnoblastic Hydroid (*Ichthyocodium sarcotretis*) epizoic on a new Parasitic Copepod (*Sarcotretis scopeli*) infesting *Scopelus glacialis* Ros.

Professor Jungersen very kindly allowed us to copy the lantern slides which he exhibited at the time, and these are now reproduced on page 352 to illustrate his interesting description, which is as follows:—

The Hydroid coats more or less of the external part of a parasitic Copepod deeply sunk into the body of *Scopelus glacialis* (see Figure 384, page 352). It consists of:—

(1) Polypes, devoid of tentacles and growing from a network of delicate tubes in a basal membrane without perisarc; and:—

(2) Medusae-buds, arising from the base of the polypes. The largest buds possess a bell with two marginal tentacles, four simple radial canals and a manubrium. When fully developed they are set free as Medusae (Anthomedusae). This new Hydroid, *Ichthyocodium sarcotretis* (see Figure 387), is related to *Hydrichthys mirus* Fewkes, epizoic on the fish *Seriola zonata*. With the *Hydrichthys* it has to be adopted into the family of Corynidae, as defined by Stechow (1909). The Parasitic Copepod, *Sarcotretis scopeli* (see Figure 385), represents a new genus and species of the family Lernaeidae, allied to genera like *Peroderma*, *Lernaeënicus*, *Lernaea* and *Pennella*.

The adult female has an elongated body, the middle part of the long genital segment constricted into a narrow, firmly chitinized stalk; only the distal claviform part behind the stalk protrudes outside the host. Cephalothorax with dorsal shield fully preserved; two large clumsy outgrowths arise below the margins of the shield, but no other outgrowths are present. No eyes are visible. Antennules are linear, antennae cheliform, the sipho large; only one pair of maxillipeds; three pairs of abdominal feet, the two anterior biramous, the posterior with a single ramus; three free abdominal segments with terga and sterna well developed. It is found in the eastern part of the Atlantic, inserted into the body of *Scopelus glacialis*, the body wall of which it pierces, penetrating to the alimentary tract.

A series of *Metamorphosis-stages* has been found on the same species of fish, namely,

(1) A *Cyclops-stage* (see Figure 388) resembling that of *Lernaea branchialis* and capable of moving along on its host and of attaching itself by means of its strong cheliform antennae.

(2) Four *Pupal-stages* (see Figures 388 and 386) passively fixed to their host by means of a hardened secretion from the rostrum. Inside the last Pupa the copulatory form has been observed. After impregnation the female takes up parasitic life anew, but in a more intense form; it pierces the skin of *Scopelus glacialis*, and, gradually growing, it penetrates through the muscles and reaches by and by the intestines of the host.

The triple association between the Fish, the Copepod, and the Hydroid seems to be a regular one: of fourteen adult *Sarcotretes* seven carry the *Ichthyocodium*; and the loss of tentacles in the Polypes of the latter seems to show that the Hydroid in some way or other depends on the Fish for getting its food.

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THE FACE OF THE SKY FOR OCTOBER.

By A. C. D. CROMMELIN, B.A., D.Sc., F.R.A.S.

TABLE 60.

Date.	Sun. R.A.	Sun. Dec.	Moon. R.A.	Moon. Dec.	Mercury. R.A.	Mercury. Dec.	Venus. R.A.	Venus. Dec.	Mars. R.A.	Mars. Dec.	Jupiter. R.A.	Jupiter. Dec.	Saturn. R.A.	Saturn. Dec.	Uranus. R.A.	Uranus. Dec.	Neptune. R.A.	Neptune. Dec.
Greenwich Noon.	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m.	°
Oct. 2	12 31·9	S. 3·4	14 28·3	S. 18·7	13 15·5	S. 8·0	10 36·6	N. 9·9	6 38·2	N. 23·5	18 40·2	S. 23·4	5 9·2	N. 21·2	20 24·6	S. 20.0	8 0·0	N. 20·1
,, 7	12 50·1	5·4	19 23·4	S. 26·9	13 44·2	11·4	10 59·7	7·7	6 48·5	23·5	18 42·2	23·4	5 9·1	21·2	20 24·4	20.0	8 0·3	20·1
,, 12	13 8·5	7·3	23 19·0	S. 5·0	14 12·4	14·6	11 22·6	5·5	6 58·2	23·4	18 44·5	23·3	5 8·7	21·2	20 24·3	20·0	8 0·5	20·1
,, 17	13 27·0	9·1	2 59·2	N. 21·4	14 40·0	17·4	11 45·4	3·2	7 7·3	23·3	18 47·1	23·3	5 8·2	21·2	20 24·3	20.0	8 0·7	20·1
,, 22	13 45·8	10·9	7 41·7	N. 26·0	15 7·1	19·8	12 8·1	N. 0·8	7 15·8	23·2	18 49·9	23·2	5 7·4	21·2	20 24·4	20.0	8 0·9	20·1
,, 27	14 4·9	S. 12·7	12 13·8	S. 2·5	15 33·0	S. 21·8	12 30·9	S. 1·6	7 23·4	N. 23·2	18 53·0	S. 23·2	5 6·5	N. 21·1	20 24·6	S. 19·9	8 1·0	N. 20·1

TABLE 61.

Date.	Sun. P	Sun. B	Sun. L	Moon. P	Mars. P	Mars. B	Mars. L	Mars. T	Jupiter. P	Jupiter. B	Jupiter. L_1	Jupiter. L_2	Jupiter. T_1	Jupiter. T_2
Greenwich Noon.	°	°	°	°	°	°	°	h. m.	°	°	°	°	h. m.	h. m.
Oct. 2	+26·2	+6·6	348·2	+17·5	−20·9	+5·4	299·2	4 10 *e*	−5·2	−1·6	253·5	110·2	2 56 *e*	6 54 *e*
,, 7	26·4	6·3	282·2	− 7·5	19·8	6·3	251·5	7 26 *e*	5·4	1·5	322·1	140·7	10 54 *e*	6 4 *e*
,, 12	26·4	6·0	216·3	−21·5	18·6	7·1	203·9	10 41 *e*	5·6	1·5	30·7	171·2	9 1 *e*	5 13 *e*
,, 17	26·3	5·6	150·3	−15·6	17·4	7·8	156·4	1 17 *m*	5·9	1·5	99·2	201·5	7 9 *e*	4 23 *e*
,, 22	25·9	5·2	84·4	+ 9·1	16·3	8·4	109·1	4 32 *m*	6·2	1·5	167·7	231·9	5 16 *e*	3 33 *e*
,, 27	+25·4	+4·8	18·4	+21·9	−15·3	+9·0	61·9	7 45 *m*	−6·5	−1·5	236·1	262·1	3 24 *e*	2 43 *e*

P is the position angle of the North end of the body's axis measured eastward from the North Point of the disc. B, L are the helio-(planeto-)graphical latitude and longitude of the centre of the disc. In the case of Mars, T is the time of passage of Fastigium Aryn across the centre of the disc. In the case of Jupiter, L_1 refers to the equatorial zone; L_2 to the temperate zones; T_1, T_2 are the times of passage of the twozero meridians across the centre of the disc; to find intermediate passages apply multiples of $9^h\ 50\frac{1}{2}^m$, $9^h\ 55\frac{1}{2}^m$ respectively.

The letters *m*, *e*, stand for morning, evening. The day is taken as beginning at midnight.

The asterisk indicates the day following that given in the date column.

THE SUN continues his Southward march, but with slackening speed. Sunrise during October changes from 6.1 to 6.53, sunset from 5.39 to 4.35. Its semi-diameter increases from 16′ 0″ to 16′ 9″. Outbreaks of spots in high latitudes should be watched for.

MERCURY is an evening star. It reaches greatest elongation (23½° E) on November 2nd, but, being South of Sun, is not well placed for observation by Northern observers. Illumination diminishes from Full to ⅞. Semi-diameter increases from 2½″ to 3″.

VENUS is a morning star, rising 3 hours before the Sun. Semi-diameter diminishes from 6″ to 5½″. At beginning of month ⅝ of disc is illuminated; at end of month $\frac{9}{10}$. Being North of Sun it is favourably placed for Northern observers.

THE MOON.—First Quarter $7^d\ 1^h\ 46^m\ m$; Full $15^d\ 6^h\ 7^m\ m$; Last Quarter $22^d\ 10^h\ 53^m\ e$. New $29^d\ 2^h\ 29^m\ e$. Apogee $12^d\ 3^h\ e$, semi-diameter 14′ 44″. Perigee $28^d\ 4^h\ m$, semi-diameter 16′ 36″. Maximum Librations, 5^d 8° W, 5^d 7° N, 20^d 7° S., 21^d 6° E. The letters indicate the region of the Moon's limb brought into view by libration. E. W. are with reference to our sky, not as they would appear to an observer on the Moon.

MARS is a morning Star, in Gemini, semi-diameter 4½″, defect of illumination over a second. It will reach Opposition early in January, so the season of observation is beginning. The North Pole is now turned towards us.

TABLE 62. Occultations of stars by the Moon visible at Greenwich.

Date.	Star's Name.	Magnitude.	Disappearance. Mean Time.	Disappearance. Angle from N. to E.	Reappearance. Mean Time.	Reappearance. Angle from N. to E.
1913.			h. m.		h. m.	
Oct. 2 ...	BAC 4867	6·4	5 56 *e*	77°	—	—
,, 4 ...	BAC 5603	6·0	5 2 *e*	100	6 18 *e*	273°
,, 10 ...	39 Aquarii	6·2	7 32 *e*	16	8 34 *e*	277
,, 11 ...	45 Aquarii	6·1	0 11 *m*	69	1 15 *m*	224
,, 13 ...	BAC 57	6·3	5 53 *e*	115	6 9 *e*	181
,, 14 ...	ϵ Piscium	4·5	7 15 *e*	79	8 18 *e*	211
,, 16 ...	27 Arietis	6·4	6 1 *e*	113	6 37 *e*	194
,, 17 ...	66 Arietis	6·1	9 59 *e*	94	11 0 *e*	213
,, 19 ...	BAC 1648	6.4	11 13 *e*	44	0 10* *m*	289
,, 21 ...	BD+26°1481	7·0	—	—	8 59 *e*	234
,, 21 ...	BAC 2383	6·5	10 21 *e*	49	11 2 *e*	314
,, 28 ...	BD−8°3456	6·8	—	—	4 58 *m*	242

From New to Full disappearances take place at the Dark Limb, from Full to New reappearances.

The asterisk indicates the day following that given in the date column.

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JUPITER is now rather low in the West. Polar semi-diameter, 17¼″ in mid-October.

TABLE 63.

Day.	West.	East.	Day.	West.	East.
Oct. 1	432 ○	1	Oct. 17	43 ○	12
,, 2	43 ○	2●1●	,, 18	42 ○	3●1●
,, 3	431 ○	2	,, 19	421 ○	3
,, 4	24 ○	13	,, 20	4 ○	213
,, 5	21 ○	43	,, 21	1 ○	32 4●
,, 6	○	1234	,, 22	28 ○	14
,, 7	1 ⊙	24	,, 23	312 ○	4
,, 8	32 ○	14	,, 24	3 ○	124
,, 9	31 ○	4 2●	,, 25	⊙	4 3●1●
,, 10	3 ⊙	24	,, 26	21 ○	34
,, 11	2 ○	134	,, 27	○	2134
,, 12	21 ○	43	,, 28	1 ○	324
,, 13	4 ○	123	,, 29	23 ○	41
,, 14	41 ○	32	,, 30	34☿ ○	
,, 15	432 ○	1	,, 31	43 ○	12
,, 16	4312 ○				

Configuration at $6^h\ 30^m m$ for an inverting telescope.

Satellite phenomena visible at Greenwich, $1^d\ 8^h\ 22^m$ I. Tr. I., $9^h\ 41^m$ I. Sh. I.; $2^d\ 5^h\ 37^m$ I. Oc. D., $8^h\ 4^m\ 36^s$ II. Ec. R.; $9^h\ 12^m\ 41^s$ I. Ec. R.; $3^d\ 6^h\ 29^m$ I. Sh. E.; $7^d\ 5^h\ 57^m$ III. Tr. I., $9^h\ 16^m$ III. Tr. E.; $9^d\ 7^h\ 33^m$ I. Oc. D.; $10^d\ 6^h\ 5^m$ I. Sh. I., $7^h\ 5^m$ I. Tr. E., $8^h\ 24^m$ I. Sh. E.; $11^d\ 5^h\ 25^m$ II. Sh. E., $5^h\ 36^m\ 30^s$ I. Ec. R.; $13^d\ 7^h\ 44^m$ IV. Sh. I.; $16^d\ 7^h\ 54^m$ II. Oc. D.; $17^d\ 6^h\ 44^m$ I. Tr. I., $8^h\ 1^m$ I. Sh. I.; $18^d\ 5^h\ 9^m$ II. Sh. I., $5^h\ 25^m\ 43^s$ III. Ec. D., $5^h\ 29^m$ II. Tr. E., $7^h\ 31^m\ 33^s$ I. Ec. R., $8^h\ 1^m$ II. Sh. E., $8^h\ 44^m\ 34^s$ III. Ec. R.; $21^d\ 5^h\ 24^m$ IV. Oc. D., $8^h\ 43^m$ IV. Oc. R.; $5^h\ 19^m$ II. Tr. I., $5^h\ 56^m$ I. Oc. D., $7^h\ 44^m$ II. Sh. I., $7^h\ 47^m$ III. Oc. R., $8^h\ 10^m$ II. Tr. E.; $26^d\ 5^h\ 31^m$ I. Tr. E., $6^h\ 45^m$ I. Sh. E.; $27^d\ 5^h\ 18^m\ 31^s$ II. Ec. R.; $30^d\ 5^h\ 44^m$ IV. Sh. E. All these are in the evening hours, the planet setting before midnight. Attention is called to the double eclipses of 2^d, 18^d, 25^d. On the 25th there is only one satellite visible outside the disc. Satellites 1, 2, 4, are all near together on 30th.

SATURN is a morning star, in Taurus, in a good position for observation. Polar semi-diameter 9″. P. is −4°·9; ring major axis 46″, minor 20½″. The ring is very widely open. It is of interest to examine the exact amount of overlap beyond the planet's pole.

East Elongations of Tethys (every fourth given), $2^d\ 0^h\cdot 6m$, $9^d\ 1^h\cdot 8e$, $17^d\ 3^h\cdot 0m$, $24^d\ 4^h\cdot 2e$, Nov. $1^d\ 5^h\cdot 4m$; Dione (every third given), $1^d\ 2^h\cdot 3e$, $9^d\ 7^h\cdot 4e$, $18^d\ 0^h\cdot 4m$; $26^d\ 5^h\cdot 4m$; Rhea (every second given), $3^d\ 7^h\cdot 9e$, $12^d\ 8^h\cdot 7e$, $21^d\ 9^h\cdot 5e$, $00^d\ 10^h\cdot 2e$. For Titan and Iapetus E.W. mean East and West Elongations; I. Inferior (North) Conjunctions, S. Superior (South) ones. Titan, $1^d\ 7^h\cdot 4e$ I., $5^d\ 3^h\cdot 8e$ W.; $9^d\ 3^h\cdot 2e$ S., $13^d\ 6^h\cdot 1e$ E., $17^d\ 5^h\cdot 9^d e$ I., $21^d\ 2^h\cdot 3e$ W., $25^d\ 1^h\cdot 5e$ S., $29^d\ 4^h\cdot 1e$ E.; Iapetus, $20^d\ 7^h\cdot 4m$ I.

URANUS is an evening star. Semi-diameter, 1¾″. About 2° S. of ρ Capricorni.

NEPTUNE is a morning star.

METEOR SHOWERS (from Mr. Denning's List):—

Date.	Radiant. R.A.	Radiant. Dec.	Remarks.
	°	°	
July to Oct. ...	355	+ 72	Swift, short.
Aug. to Oct. 2	74	+ 42	Swift, streaks.
Sep. 28 to Oct. 9	320	+ 40	Slow, small.
Oct. 2 ...	230	+ 52	Slow, bright.
,, 4 ..	310	+ 79	Slowish.
,, 8 ...	77	+ 31	Swift, streaks.
,, 8-14 ..	45	+ 58	Small, short.
,, 14 ...	133	+ 68	Rather swift.
,, 15 ...	31	+ 9	Slow.
,, 18-20 ...	92	+ 15	Swift, streaks.
,, 23 ...	100	+ 13	Swift, streaks.
,, 29 ...	109	+ 23	Very swift.

DOUBLE STARS AND CLUSTERS.—The tables of these given last year are again available, and readers are referred to the corresponding month of last year.

VARIABLE STARS.—Tables of these will be given each month; the range of R.A. will be made four hours, of which two hours will overlap with the following one. Thus the present list includes R.A. 22^h to 2^h, next month 0^h to 4^h, and so on.

TABLE 64. NON-ALGOL STARS.

Star.	Right Ascension h. m.	Declination. °	Magnitudes.	Period. d.	Date of Maximum.
X Aquarii	22 14	−21·3	7·6 to 11	315	July 31.
TX Pegasi	22 14	+13·2	8·5 to 9·2	123	July 20, Nov. 20.
S Lacertae	22 25	+39·8	8·0 to 12·5	237·5	July 29.
R Lacertae	22 39	+41·9	8·3 to 13·9	299·8	July 1.
U Lacertae	22 44	+54·7	8·5 to 9·1	659	July 5.
S Aquarii	22 52	−20·8	8·0 to 14·5	279·7	July 25.
SS Andromedae	23 8	+52·4	8·9 to 9·6	165·8	Aug. 5.
TY Andromedae	23 10	+40·3	8·2 to 9·6	144	Oct. 19.
W Pegasi	23 15	+25·8	7 to 13	342·6	Aug. 13.
S Pegasi	23 16	+ 8·4	7·3 to 13·1	317·5	Aug. 10.
R Aquarii	23 39	−15·8	6·0 to 10·8	387·16	Oct. 6.
V Cephei	23 52	+82·7	6·2 to 7·0	362	Nov 20.
R Cassiopeiae...	23 54	+50·9	4·8 to 13·2	431·6	July 21.
Y Cassiopeiae...	23 59	+55·2	8·4 to 13·9	410	Nov. 22.
SS Cassiopeiae	0 5	+51·1	8·5 to 11·7	139·6	Sep. 6.
T Ceti	0 17	−20·5	5·4 to 6·9	280·6	Oct. 16 (min.)
T Cassiopeiae...	0 19	+55·3	6·7 to 12·5	443·0	Oct. 7.
TU Cassiopeiae	0 22	+50·8	7·7 to 8·5	59	Oct. 29.
TU Andromedae	0 28	+25·5	7·7 to 11	317	Oct. 27.
RX Cephei	0 43	+81·5	7·4 to 7·9	130	Oct. 24 (min.)
RV Cassiopeiae	0 48	+46·9	8 to 13	327	Oct. 24.
Z Ceti	1 2	− 1·9	8·8 to 13·5	184·5	Oct. 6.
S Piscium	1 13	+ 8·5	8·2 to 14·7	404·45	Sep. 6.
X Cassiopeiae	1 51	+58·8	8·4 to 12.2	367·0	Nov. 22.

β Lyrae minima Oct. $13^d\ 9^h e$, $26^d\ 7^h e$, Period $12\ \ 21\cdot 8^h$.

Algol minima Oct. $1^d\ 4^h\ 21^m e$, $10^d\ 6^h\ 48^m m$, $13^d\ 3^h\ 37^m m$, $16^d\ 0^h\ 26^m m$, $18^d\ 9^h\ 15^m e$, $21^d\ 6^h\ 3^m e$, Period $2^d\ 20\cdot 8^h$.

XUM

THE PLUMAGE QUESTION.

NEARLY thirty years have now passed since an organised effort was begun in this country to discourage the fashion of wearing the plumage of beautiful wild birds. The late Mr. George Musgrave, in the year 1885, founded the Selborne Society for the preservation of birds of beautiful plumage; rare and useful birds; and pleasant places.* About the same time, namely, on December the 18th of that year, the Rev. F. O. Morris wrote to *The Times* advocating the formation of a Plumage League and this became the plumage section of the Selborne Society. From the comments made by the Editor of *The Gentleman's Magazine* upon a letter received from Mr. Musgrave, we gather that the latter had learned the difficulty of enforcing protective Acts and relied upon persuasion to overcome the results of fashion.

A prospectus of the Selborne Society, dated December, 1885, states that its object was to discourage the wholesale destruction of birds, and that the trade had plenty of material available "in the feathers of birds killed for food, the game birds of the world, and of birds farmed or protected for their plumage." The support which the Society got from public men like Tennyson, Avebury, Leighton, John Ruskin, and Robert Browning, as well as from many lady members of the aristocracy, enabled it to wield considerable influence, and to arouse an interest in the preservation of birds.

One result of this was that in the year 1889, a special Society (now the Royal Society) for the Protection of Birds was brought into existence. Its object that bears upon the plumage question reads as follows:—"To discourage the wanton destruction of birds and the wearing of feathers of any bird not killed for the purposes of food, other than the Ostrich, but to take no part in the question of the killing of game birds and legitimate sport of that character." Of recent years the energies of this Society have been directed towards obtaining legislation which will prevent the importation of plumage, but none of the Bills which have been produced have become law; for it is obvious that without some international agreement, the trade in feathers, which is not an inconsiderable one, belonging to this country would simply be transferred to the Continent.

In the meantime fashions which call for feathers still prevail, and the killing of birds goes on. A moment's thought shows that it is to the interest of the plumage trade that the supply of feathers for which there is demand should not fail through the extinction of the species producing them. The result of domesticating the Ostrich has been little short of marvellous from the commercial point of view, and it seemed possible that if the naturalists and the traders were to find some common programme, even if their ultimate objects were by no means the same, something might be done to save species in immediate danger of extermination.

Mr. S. L. Bensusan, the well-known writer, and the Secretary of the Selborne Society happened to discuss the matter informally, and the latter brought it before the Council of the Society which empowered him and Mr. Holte Macpherson to confer with others including members of the trade. The result, after much delicate negotiation, was the formation of the Committee for the Economic Preservation of Birds. On this body there are members specially appointed by the Selborne Society and also by the London Chamber of Commerce. The British Ornithologists' Union has accepted the invitation to appoint a delegate, but the Royal Society for the Protection of Birds has not yet done so. As will be seen from the list which we print below, many of the leading zoölogists have joined the Committee which is hard at work collecting information bearing on the question.

Quite recently (on August the 4th) another Bill was brought before the House of Commons forbidding the importation of any plumage except that of Ostriches and Eider Ducks. Licences may be granted for the importation of specimens for museums and for scientific research, but no provision is made for the obtaining of feathers by fly-fishermen. The bill is open to the same objection as has been raised in previous cases; moreover, plumage forming part of wearing apparel can be brought in by the owners, and birds may be imported alive. If any attempt is made to bring in living specimens for trade purposes the amount of mortality will be very great and the result of the bill if it becomes law will be to encourage the killing of British birds for their plumage, though the Secretaries of State and the Lord Lieutenant of Ireland are given power by the Bill to make orders for the protection of wild birds independently of County and Borough Councils, probably with an eye to remedying the possible evil results to which allusion has just been made.

THE COMMITTEE FOR THE ECONOMIC PRESERVATION OF BIRDS.

F. G. AFLALO, F.R.G.S., F.Z.S.
†‡S. L. BENSUSAN.
Professor GILBERT BOURNE, D.Sc., F.R.S., Sec. L.S. (University of Oxford).
WALTER E. COLLINGE, M.Sc., F.L.S., F.E.S.
Professor A. DENNY, M.Sc. (University of Sheffield).
†C. F. DOWNHAM (Member of the London Chamber of Commerce).
F. MARTIN DUNCAN, F.R.P.S., F.R.M.S.
†G. K. DUNSTALL (Member of the London Chamber of Commerce).
Professor JAMES COSSAR EWART, M.D., F.R.S. (University of Edinburgh).
Professor F. W. GAMBLE, D.Sc., F.R.S., F.Z.S., (University of Birmingham).
Professor J. STANLEY GARDINER, M.A., F.R.S., F.Z.S. (University of Cambridge).
Professor MARCUS HARTOG, M.A., D.Sc., F.L.S. (University College, Cork).
W. D. HENDERSON, M.A., B.Sc., Ph.D. (University of Bristol).
Professor J. P. HILL, D.Sc., F.L.S., F.Z.S. (University of London).
MATTHEW DAVENPORT HILL, M.A., F.Z.S. (Eton College).
H. KNIGHT HORSFIELD.
COLLINGWOOD INGRAM.
†LOUIS JOSEPH (Member of the London Chamber of Commerce).
†Professor H. MAXWELL LEFROY (Imperial College of Science),
†A. HOLTE MACPHERSON, M.A., B.C.L., F.Z.S. (Vice-President of the Selborne Society).
Professor A. MEEK, M.Sc., F.L.S. (University of Durham).
†P. CHALMERS MITCHELL, LL.D., D.Sc., F.R.S. (Secretary of the Zoölogical Society of London).
†C. E. MUSGRAVE (Secretary of the London Chamber of Commerce).
Professor ROBERT NEWSTEAD, M.Sc., F.R.S., A.L.S. (University of Liverpool).
†HUBERT H. POOLE (Librarian of the Selborne Society).
HUGH SCOTT, M.A., F.L.S. (University Museum of Zoölogy, Cambridge).
†W. LUTLEY SCLATER, M.A. (British Ornithologists' Union).
C. G. SELIGMANN, M.B., F.R.C.P. (University of London).
The Rev. THOMAS R. R. STEBBING, M.A., F.R.S., F.L.S.
Professor D'ARCY W. THOMPSON, C.B., D.Litt. (University College, Dundee).
H. W. MARETT TIMS, M.A., M.D., F.L.S., F.Z.S. (University of London).
†‡WILFRED MARK WEBB, F.L.S., F.R.M.S. (Secretary of the Selborne Society).
W. PERCIVAL WESTELL, F.L.S., M.B.O.U.
MARCUS WOODWARD.

The Honorary Secretaries, who may be addressed c/o The Selborne Society, 42, Bloomsbury Square, would be very glad to have the names of others who would care to join the Committee.

* *The Gentleman's Magazine*, December, 1885, page 619.

† Members of the Executive Committee. ‡ Honorary Secretaries.

XUM

REVIEWS.

CHEMISTRY.

Practical Agricultural Chemistry.—By S. J. M. AULD, D.Sc., F.I.C., and D. R. EDWARDES-KER, B.A., B.Sc. 243 pages. 32 illustrations. 8-in.×5-in.

(John Murray. Price 5/- net.)

The authors of this handbook call attention to the fact that students at agricultural colleges frequently finish their course without having grasped the essential connection between their laboratory work and the chemical changes in Nature which it is intended to make clear. For this reason they have dwelt fully on the qualitative examination of plant products, which in their experience is likely to be of more service to the general student than the study of quantitative methods. On this point, however, we should be inclined to differ from them, since there can be little doubt qualitative chemistry gains much by being taught quantitatively. It must not be inferred from this that quantitative work is neglected, for full outlines are given of methods of analysing plants and their constituents, soils, fertilisers, and feeding stuffs, and dairy products, the ground covered being that required for the London B.Sc. degree in Agricultural Chemistry. In general these methods are accurate and up-to-date, although inaccuracies may be noted in certain places. For example, in the determination of the Iodine value by Hübl's method insufficient time is allowed for the absorption, and the iodine value given for linseed oil (172) is far lower than is usual when a longer time is allowed. A little more space might have been given with advantage to some special subjects, such as, for instance, the analysis of water and the difficult problem of interpreting the analytical results.

C. A. M.

A Text-book of Experimental Metallurgy and Assaying.—By A. ROLAND GOWER. 163 pages. 50 illustrations. 7½-in.×5-in.

(Chapman & Hall. Price 3/6 net.)

Metallurgical processes are too often learned by rote without any thorough understanding of the chemical reäctions upon which they are based. Such rule-of-thumb methods may give good results with the more common ores, but leave the metallurgist at a loss when he is called upon to assay minerals of unusual composition. The author of this book, therefore, rightly lays stress upon the necessity for the student to learn the chemistry of metallurgy, though he assumes that some elementary knowledge has already been acquired. The book has been considerably enlarged since its first appearance many years ago, and now covers the ground required for the Lower Examination of the Board of Education in this subject. The exercises are simply described and good diagrams are provided where necessary, so that the book should prove most helpful to beginners. Among the various assays is included a section on the examination of fuels, including the determination of the calorific value. The value of this would have been increased by directions for obtaining an average sample, which is one of the chief difficulties in the analysis of coal.

C. A. M.

An Introduction to the Chemistry of Plant Products.—P. Haas, D.Sc., and T. G. Hill, A.R.C.S., F.L.S. 401 pages. 9½-in.×6-in.

(Longmans, Green & Co. Price 7/6 net.)

The aim of this book is to enable students of botany and vegetable physiology to understand the nature of the chemical changes that take place in plants, and the biological meaning of those changes. The principal groups of chemical constituents in plants, such as fats, carbohydrates, pigments, proteins, and enzymes are, therefore, described at some length, their chief qualitative reactions and methods for their estimation being also outlined in each of the sections. As a rule, the analytical methods given are full enough for a trained chemist to follow without having recourse to another work, but in some instances either too much or too little detail is given. This is notably the case in the section dealing with the analysis of the fats and oils, where the directions are more than are required for understanding the meaning of an analysis, but are not sufficient to obviate the need of reference to other books. For instance, since the analytical methods are given at length, tables of the values of the principal vegetable oils and fats should have been added as an aid to the interpretation of the results.

In this connection it may be noted that the insoluble bromide test, devised by Hehner and the present reviewer, is here incorrectly described as the "hexabromide test," whereas the evidence points to the compound being the bromide of a mixed glyceride and certainly not a hexabromide. But these are only minor defects in a most valuable book, which ought to find a place upon the shelves of every agricultural chemist and botanist. It should be added that there is an excellent index, and that full references are given in footnotes to the authorities quoted in the text.

C. A. M.

GEOGRAPHY.

Maps and Survey.—By ARTHUR R. HINKS. 206 pages. 24 illustrations. 8¾-in.×5½-in.

(The Cambridge University Press. Price 6/- net.)

Those interested in Geography, and particularly those connected with the teaching of the subject in universities and colleges, have to thank Mr. Hinks for two valuable contributions this year to the available literature on the practical side of the science. Except for official publications of this country and the United States, the systematic works on maps and map-making in English have been special treatises by pure mathematicians, or articles in the encyclopædias. In "Maps and Survey," as in "Map Projections," the demand on the mathematics of the reader is not large, and the special needs of the geographer have been kept in the forefront.

The present volume consists of chapters on Maps, Map Analysis, Route Traversing, Simple Land Survey, Compass and Plane Table Sketching, Topographical Survey, Geodetic Survey and Survey Instruments. There are numerous illustrations, mostly of a high order, and the student who can handle and examine the instruments and engage in simple exercises easily devised will obtain from this cheap and well-written book training of a nature his predecessors found it difficult to acquire.

No doubt the parts on plane-table and theodolite work will appeal most to this class of reader, and both are interesting and well done. Here, as throughout the book, the author indicates the possibilities and particular applicabilities of each instrument, the errors permissible, and methods of obtaining accuracy. We were struck, for example, by the treatment of resection and the triangle of error in plane-table survey, and the adjustment of rounds of angles taken by the theodolite. Geodesy is a branch of the science of Geography that is not widely studied or appreciated, and the most interesting chapter on Geodetic Survey should do much towards developing a wider and more intelligent knowledge of this fascinating subject. For Geographers and Geologists alike the theory of Isostasy has no little importance and the present volume presents a useful introduction to it.

We found the first two chapters a little "slow"; and yet they contain a great deal of useful matter which can be got at by the much slower process of examining maps of many kinds of details. To learn intelligently the maps must be studied, but the book provides valuable fore-knowledge and a guide to the work. It is difficult to see how some dullness could be avoided.

In Chapter IV., a slight alteration of the text would conduce to readier grasping of the method of simple levelling.

On page 101, the figure of the prismatic compass is given as Plate XIII instead of Plate XIV, and on page 102 the special graduation of the card of the prismatic compass might be more fully treated; on page 129, the phrase, "distance $= s \tan \theta$" should read "distance is $s \cot \theta$" unless there is something wrong in the text; and on page 148 is not stated that the correction $- H^2/2L$ is an approximation to $- L (1 - \cos \theta)$. In a new edition doubtless these and other slight matters will be amended with advantage to a very excellent book.

A. S.

HORTICULTURE.

Garden Work.—By WILLIAM GOOD, F.R.H.S. 359 pages. 38 plates. Numerous figures.

(Blackie & Son. Price 5/- net.)

This is a good practical book written by a practical man who nevertheless has a theoretical knowledge of his art, and does not forget in appropriate places to say something about the structure of plants and their physiology. The bulk of the book, however, deals with cultivation. Definite instructions are given under the heading of each kind of vegetable or flower, and what is of considerable importance and value is a short list of selected varieties which the author specially recommends. Cultivation in window boxes, in frames, and in greenhouses, is also dealt with. There is a chapter on propagation and another on hybridisation and cross-breeding, while, after some words on the eradication of weeds and the aims of floral decoration, the book is completed by the consideration of the birds and insects of the garden and plant diseases. We are glad to see that the author suggests that advantage should be taken of birds which do good by destroying pests and that they should afterwards be prevented where possible from doing harm to fruit by netting the trees and bushes. A number of good diagrams have been introduced, with a series of photographic illustrations and some coloured plates. These add considerably to the attractiveness of the book, which we heartily commend to our readers.

W. M. W.

NATURAL HISTORY.

A Naturalist in Cannibal Land—By A. S. MEEK. 238 pages. 36 illustrations. 9-in.×6-in.

(T. Fisher Unwin. Price 10/6 net.)

Apart from being a stirring narrative of fortune and misfortune in collecting natural history specimens in out of the way parts of the world, Mr. Meek's book is in a way autobiographical; for it shows how he became a collector and the way in which the desire for adventure caused him to take up the career which he has so successfully followed. Of course, a good deal of the book is occupied with an account of the various finds of birds and butterflies which were discovered and sent home to Tring Museum for Mr. Walter Rothschild, but we get a very good idea of some of the habits of the natives; for instance, in the New Guinea Hill Country, when the traveller is on a journey, the natives of a village will know that he is coming many days before he gets there, and in the following way. The villages are built as a rule on the tops of spurs, and early in the morning a crier will go to a selected spot and sing across the valley to the next village. As soon as an answering cry is received the crier will chant the news he wishes to convey. Generally the message is repeated twice, and, if necessary, it will be sent on to other villages. The account of the position of women is of interest, for in some places it appears that they are becoming emancipated so far as to be able to choose their own husbands, and it is amusing to read how, on one or two occasions, Mr. Meek interfered on their behalf and became a matchmaker.

It is curious that Mr. Meek should have had so little trouble as he did with the natives, but he seems to have been most discreet in his treatment of them.

Among the interesting photographs which illustrate the book is one of an albino Native Child from the Trobiands. Another shows the Papuan kiss, which consists of the rubbing together of noses.

W. M. W.

ORNITHOLOGY.

The Food of some British Wild Birds.—By WALTER E. COLLINGE, M.Sc., F.L.S., F.E.S. 109 pages. 8½-in.×5½-in.

(Dulau & Co. Price 4/6.)

Mr. Walter E. Collinge has made a really valuable contribution to economic ornithology, which is the outcome of much keen observation, and it is to be hoped that in the near future a very great deal more scientific evidence will be produced in this country, as to the good and harm which wild birds do. Mr. Collinge is also to be congratulated on his freedom from bias, and though it is possible that everyone will not agree with his findings, seeing that the habits of birds vary very considerably in different places and under different conditions, he has afforded a most useful basis for argument.

Three thousand adult birds and three hundred nestlings were examined, and twenty-nine species are discussed. Lists are given of the articles of diet by eating which the birds may be deemed beneficial, injurious or neutral, and then the whole question is summed up. We give Mr. Collinge's conclusions in each case.

Missel Thrush.—Should be kept down in fruit-growing districts for four months of the year; it does more harm than it does good in the rest.

Song Thrush.—Cannot be regarded as anything but very beneficial to the fruit grower and horticulturalist.

Blackbird.—One of the most destructive birds which the fruit-grower has to contend with.

Whitethroat.—The bulk of the food consists of injurious insects.

Blackcap.—Mr. Collinge thinks that if this bird becomes numerous it will be a very undesirable orchard pest. We should like for sentimental reasons to hear a better account of this bird.

Great Tit, Blue Tit and Wren.—Distinctly beneficial to the fruit grower.

Goldfinch.—The worst that can be brought against this species is that it probably aids in the distribution of weed seeds.

House Sparrow.—If it were no commoner than the Robin it would more than compensate for the harm which it does.

Chaffinch.—For two months or more does great harm to sprouting corn; it requires reducing in numbers.

Linnet.—A harmless bird.

Bullfinch.—In fruit-growing districts it should be destroyed.

Yellow Bunting.—Generally speaking may be regarded as beneficial.

Starling.—Considerably reduced in numbers, would regain the good name it has borne in the past, and prove a most useful bird to the farmer.

Jay.—An almost neutral factor.

Magpie.—Beneficial to the farmer.

Jackdaw.—The good which it does far outweighs the harm.

Rook.—Not particularly beneficial; but its usefulness might be considerably increased were it less numerous.

Lark.—Does more good than harm.

Barn Owl.—A most valuable bird to the agriculturist and perfectly harmless otherwise.

Brown Owl.—Deserves all protection.

Kestrel.—The benefits this bird confers on agriculture far outweigh the harm that it occasionally does to young game.

Sparrowhawk.—Mr. Collinge shows that this bird is useful apart from its fondness for game and poultry, but for the latter reason does not advocate any protection.

Wood Pigeon.—No quarter should be shown to this bird.

One remembers, however, that in a discussion at the British Association Meeting at Dundee last year it was pointed out that when the corn eaten by this bird after the harvest had been gathered in was not counted in, the balance — which, according to the calculations of a careful observer was previously against it—was turned in its favour.

XUM

The Stock Dove.—Condemned by Mr. Collinge.

Plover.—It would be difficult to exaggerate the value of this bird to the agriculturalist.

These extracts will show Mr. Collinge's well-considered opinions, but we would urge all those who are interested in birds, from whatever point of view, to get Mr. Collinge's book and study all the interesting details and information contained therein.

W. M. W

PHYSIOLOGY.

Anaphylaxis.—By CHARLES RICHET (Paris). Translated by J. MURRAY BLIGH, M.D., with Preface by T. R. BRADSHAW, M.D., F.R.C.P. 266 pages (including Bibliography). 7-in. × 5-in.

(Constable & Co. Price 3/6 net.)

It it only eleven years since that strange and interesting condition known as Anaphylaxis was first discovered and described by the author of the monograph before us. Already an enormous literature on the subject has grown up, but Professor Richet, the pioneer, is still the greatest master of his subject, as every page of this interesting book testifies.

Anaphylaxis may be described as "the modification of the cells of an organism by the injection of a dissimilar albuminoid substance, so that they seem to reäct with greater intensity on the repetition of the injection," and is of great importance in these days of serum treatment for diphtheria, cellulitis, and other conditions. If, as was described in a recent number of this Journal, after an interval of from a few weeks to two or three years, a second injection of the serum of the same animal is administered, serious symptoms of poisoning often rapidly develop, and in some cases prove fatal. It is also probable that those curious cases in which ordinary articles of diet such as eggs, pork, strawberries, asparagus, shellfish, and so on, in some people give rise to symptoms of poisoning, are to be explained in somewhat the same manner.

The book is clearly and ably written, and should prove of the greatest possible value to those working at this subject. A very complete Bibliography is included.

S. H.

RADIOACTIVITY.

Beyond the Atom. By John Cox, M.A. 151 pages. 13 figures. 6½-in. × 4¾-in.

(The Cambridge University Press. Price 1/- net.)

This volume, No. 65 of the "Cambridge Manuals," contains an interesting and succinct account of the modern science of radioactivity and the theory of the disintegration of the atom, which may justly be regarded as the central doctrine of this science. Except for the occasional use of an unexplained technical term or two (*e.g.*, "Faraday tube of force"), the book is well adapted to the needs of general readers. Mr. Cox clearly indicates the broad lines of evidence for the disintegration theory and its advantages over the "helide" hypothesis, which in the light of so much evidence can now hardly be regarded as in any sense tenable. As Mr. Cox says, "the chemist . . . has been compelled to look 'beyond the atom,' and in the words of Blake—

> 'To see a world in a grain of sand
> And heaven in a flower;
> To grasp infinity in the palm of the hand,
> And eternity in an hour.'"

There is a statement on page 46, however, which will certainly prove misleading, as seeming to indicate that the products of radioactive disintegration are not elementary, for which there is, of course, no evidence, and which is not, I think, what Mr. Cox intends to say.

There is an interesting chapter on "The Objective Reality of Molecules." No doubt the Brownian movement, especially in the light of Perrin's wonderful investigation, does endow molecules with more reality than heretofore, and the word "objective" is not out of place. But lest we interpret this term in too metaphysical a sense, we must remember that Berkeley's arguments concerning the nature of the existence of the material world still remain; and in the last analysis it is clear that the world of science is a purely conceptual world—that it is a great hypothesis, a machine, as it were, produced by the mind in order that the mind may deal easily with its sense-impressions. But on the other hand, of course, if this view limits the meaning of "objectivity," it does nothing to invalidate physical science or to deny its truth, pragmatically understood.

H. S. REDGROVE.

ZOÖLOGY.

The British Parasitic Copepoda.—By THOMAS SCOTT, F.L.S., and ANDREW SCOTT, A.L.S. Vol. II. Copepoda Parasitic on Fishes. 72 plates. 9-in. × 6-in.

(Dulau & Co. Price 25/- net.)

In our July number we noticed the text of the latest publication of the Ray Society, dealing with the British Parasitic Copepoda. The present volume, which is issued to subscribers for the year 1913, contains the excellent plates—more than half of them coloured—the majority of which have been drawn by Mr. Andrew Scott from specimens examined by the authors.

W. M. W.

The Wanderings of Animals.—By HANS GADOW, F.R.S. 150 pages. 17 maps. 6½-in. × 5-in.

(The Cambridge University Press. Price 1/- net.)

The distribution of animals is a question which calls up all sorts of interesting matters. On many of these Dr. Gadow is able to touch in the first part of his book, which shows how animals have spread and how long they have taken to do so. Some attractive calculations are incidentally given with regard to the human species. In England the population doubles itself in fifty years, and if this was to go on, a thousand years hence the whole land surface of the globe would not afford sufficient standing room for the sixteen hundred and sixty million millions of people that would then exist. It is absolutely certain that the origin of man dates back into the Pliocene, and if we assume that the human race started as the traditional Adam and Eve pair in that period, the rate of increase necessary to account for the present total population would be so small as to render the calculation quite preposterous. Dr. Gadow gives figures which show that the rate of propagation has been always as large as it is now all over the world.

The second half of the book consists of brief accounts of the distribution of selected groups of animals, and contains a large amount of useful information in a small compass.

W. M. W.

NOTICES.

PLANT PROTECTION.—Arrangements are being made to hold a Conference on this subject in London on September the 19th. Those interested in the subject who would like to attend are invited to communicate with the Editors of "KNOWLEDGE" at 42, Bloomsbury Square, London, W.C.

CLASSES IN PHOTOGRAPHY.—Mr. Edgar Senior's elementary and advanced classes in photography at the Battersea Polytechnic begin again at 7.30 p.m. on September the 30th, and at the South-Western Polytechnic, Manresa Road, Chelsea, on September 22nd.

THE BRITISH ASSOCIATION.—This year's meeting will be held at Birmingham, under the Presidency of Sir Oliver Lodge, who will give his address on the 10th of September. The Railway Companies, on production of a voucher signed by the Secretary of the Association, will grant reduced fares, and Birmingham can now be reached on the new Great Western line in exactly two hours from Paddington. From a time-table sent to us by the Divisional Superintendent, we learn that trains depart at 9.10 and 11.5 a.m., and 1.0, 2.35, 4.0, 6.0, and 8.0 p.m.

XUM